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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association

INTERNATIONAL

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West Virginia Inspection Bureau.
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Over 4,100 Associate Members

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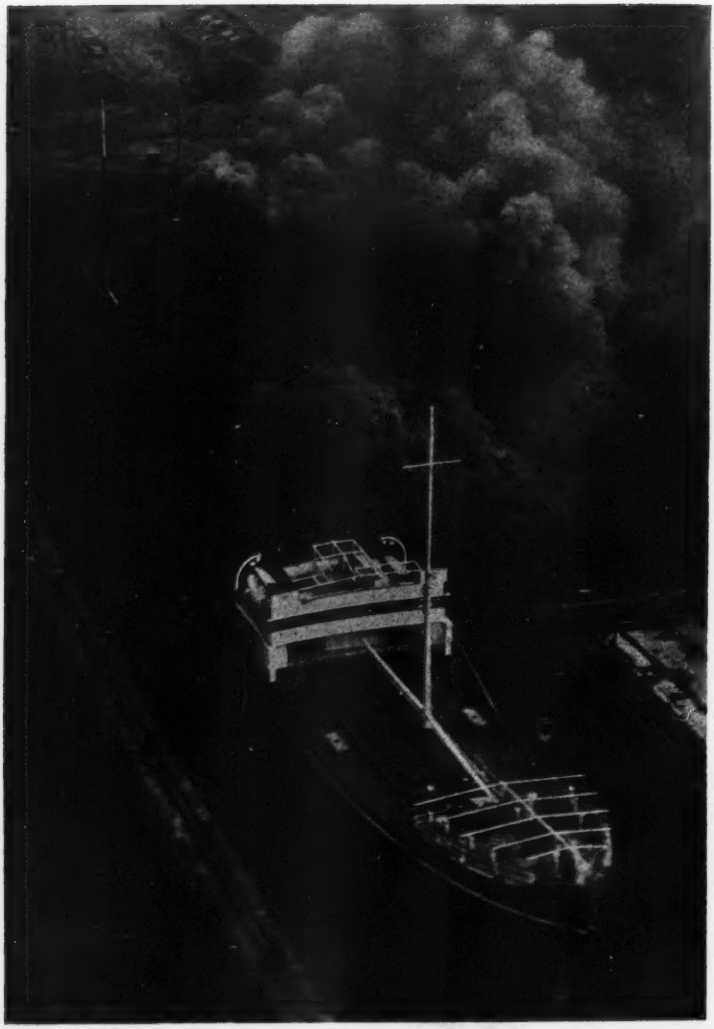
Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.



Courtesy Baltimore *Underwriter.*

The explosion and fire on the tank steamer "Mantilla" while in dry dock in Baltimore on November 19 caused the reported loss of 18 lives and 70 injuries. This is only one of a number of similar disasters which have occurred during the past year. A report on this fire and explosion will be found on page 281.

The Quarterly

Vol. 20 January, 1927 No. 3

Convictions for Arson. The announcement in the November *News Letter* of the plan of the Fire Marshals Association of North America to unite with the National Fire Protection Association as a Fire Marshals Section was received with general enthusiasm but particularly by certain of our members who have long held the opinion that among our activities in fire prevention we have not given sufficient attention to the deliberate incendiary; who have asserted that we have seen the curve of the fire loss rise inevitably with every business depression in any class of mercantile business or industry, and have made no organized effort to cope with this disconcerting fact; that we have been content with the occasional conviction of a poor pyromaniac or moron, allowing the big offenders to escape; that we have done nothing to discourage the operations of that variety of insurance agent who promotes incendiarism by issuing policies on property he has never seen to people he doesn't know.

This opinion has never seemed wholly reasonable because of the fact that it leaves out of the picture a number of important conditions and influences of a substantially modifying character. In the first place, the item of public opinion is important. The country is not yet awakened to the economic significance of the fire waste and until it is awakened whoever prosecutes incendiaries will have exceedingly hard sledding. Juries will not convict incendiaries while their members have the foolish notion that nobody is injured by a fire except the insurance companies. Should we then divert our resources and energy from educational efforts into a pursuit of incendiaries whom present unintelligent public opinion will release after we get them? We should be putting the cart before the horse. Inform our people first, and a number of our ultimate objects may be more easily attainable.

Arson Law Revisions. One very necessary project preliminary to any successful attack upon the crime of arson is the proposed revision of the laws of most of the states on this subject, which is the present cooperative undertaking of the Fire Marshals Section. (See current *News Letter* bulletins.) No better illustration of the present absurd condition of these laws under which efforts have been made for a decade to secure conviction of incendiaries could be found than the contents of certain paragraphs in a recent letter on the subject of an Ohio court opinion in a case of arson. Mr. F. R. Morgaridge, Chief of the Arson Department of the National Board of Fire Underwriters is the writer of the letter. The extracts are as follows:

I realize that if a man is caught setting fire to the building or property of another he can be indicted for Arson under the laws such as those of Ohio, Illinois, etc., but in the event the man accused could show that the owner or the person against whom the Arson is directed, consented to the burning or that the accused was acting for the owner, he could not then be convicted of Arson.

The Arson Laws of Illinois and Ohio are practically the same and several years ago this particular point arose in the trial of the case of the People versus Harris, 263 Ill. 406 (414):

"At common law one could not be convicted of Arson for burning his own building, and it follows from this rule that if the owner of a building consented to the burning of his building by another, such other person could not be guilty of Arson. In an Arson case no issue can arise in respect to the consent of the owner, unless the accused seeks to acquit himself of the criminal intent by bringing forward proof that the owner consented to the burning."

In the states of Ohio, Illinois, Iowa, etc., an indictment for Arson must charge that the defendant set fire to and burned either the building of another or the property of another.

The tenant who burns a building which he occupies but which another owns can be indicted, charged with burning the property of another. The owner who sets fire to a building, the property of himself, but occupied by another, can be indicted for Arson charged with burning the building of the tenant, but if the owner and the tenant act together and agree to burn such building, and one of them sets it on fire, then neither has committed the crime of Arson against the other, and the only crime they have committed is burning with intent to defraud the insurers.

The purpose of the Suggested Model Arson Law is to get as far away as possible from Common Law Arson, and to make it possible to indict and convict a person who sets fire to buildings or property without alleging either ownership or occupancy and without having to prove that this crime of Arson was aimed at some particular individual.

Mr. Morgaridge's clearly expressed thought reflects the character of the difficulties he has encountered even in our leading states in preventing the escape of incendiaries on technicalities resulting from loosely drawn statutes. In aid of the present effort of the Fire Marshals Section to secure the passage of the model arson law to correct such conditions as above indicated, the legal department of the National Board of Fire Under-

writers has made a careful digest of the current arson laws of the several states, and a monograph on each one has been prepared by Mr. Morgaridge pointing out the specific defects or weaknesses of the statutes. This will equip our members who are getting behind this project with authentic knowledge of the measures they are seeking to replace, and the valid criticisms that can be made of them. Our obligation to Mr. Morgaridge for this competent and laborious service is very great indeed.

* * * * *

Team Work. It is very likely that the Fire Marshals Section may find in the widely diversified membership of the N.F.P.A. a substantial source of assistance in its prosecutions of incendiaries. In fact the new section may reasonably be considered, in the words of the fire marshal of Iowa, Mr. Tracy, as the "law enforcing arm" of the N.F.P.A. whose efforts our members are logically expected to exert themselves to make effective.

While the N.F.P.A. members can, and no doubt will, be of great service in such matters to the fire marshals individually, and serve them collectively also in insuring continuity to their efforts in the field of legislation, it is in the work of fire prevention that the Fire Marshals Section may register its principal potentialities. Already the fire marshals in several states have extended the influence of their offices and at the same time strengthened the fire prevention efforts of the N.F.P.A. by going about among the cities within their jurisdiction with our field engineers, thus participating in, and becoming an important factor in this work. A closer working relation of this sort may now be anticipated in all the states. As a result of the establishment of this team work and the potentiality for big accomplishment that resides in it the office of fire marshal may cease to serve as the political football it has been in altogether too many states and the earnest and capable men who fill that office acceptably count more confidently on remaining in it.

Whatever subsidiary desirable effects may flow from the establishment of the new section it is at least reasonable to believe that the attack upon the fire waste in each state made possible by the joined hands of the fire marshals and our field engineers may realize the hopes of the far-sighted state officials at the Memphis convention who evolved the plan of becoming a working part of the N.F.P.A.

* * * * *

The Skyscraper. When one considers the prospective building programs of the big cities and notes that with the possible exception of Boston a lot of new skyscrapers will lift their heads this year in the already congested centers of most all of them, he can hardly refrain

from speculating on the final outcome of this form of abnormality, which has its genesis partly in human vanity and the desire to dazzle and surprise, and partly in the desire to realize as much rental as possible on an extravagantly valued plot of ground. The big city is itself, of course, an abnormality and is coming increasingly to be so regarded by all thoughtful persons. Decentralization, however, would be possible only through collective action, the possibilities of which in our individualistic society seem now remote. The monster seems now inevitable and increasingly menacing to comfort and safety. A few weeks ago, to discuss this necessary monster, mayors, professors, doctors, businessmen, betook themselves to St. Louis, to the 32nd annual convention of the National Municipal League. They talked feverishly about everything from city-owned taxicabs in Philadelphia to "half-baked vocational education." However, they all remembered the words of one man who stung the pride but revealed the feeling of many a metropolis dweller:

> The skyscraper has already become a plague that we may well range alongside our ancient city scourges of cholera, yellow fever, tuberculosis and slums . . .
>
> In New York it is the collective skyscraper at the city's work-a-day hub that breeds more subways, less money for other needs, and more motor vehicles in the skyscrapers' service to kill more children in the children's only playground, the roadways between the sidewalks of New York.

The speaker was Henry H. Curran, Manhattan attorney, onetime Commissioner of Immigration at Ellis Island, candidate for mayor of New York City in 1921, who is fast becoming a national figure as an anti-skyscraper man.

* * * * *

Few Fires in Finland

In this issue we present a description of fire conditions in Finland written by the secretary of the fire protection association of that country. Unlike some other European countries Finland has a plentiful supply of timber which it uses almost exclusively in all but its larger buildings. Yet for all that, the country has had nothing that could be termed a conflagration for fifty years and it has been ten years since a fire spread beyond the building in which it originated.

The reason for this remarkable record is the enforcement of certain simple fundamental regulations regarding building construction, which several conflagrations early in the 19th century taught the people were necessary. Shingle and wooden roofs are prohibited, areas between firewalls are limited, and openings in fire-resistive walls must be so placed as to prevent the spread of fire from one building to another. Heights are limited, frame buildings must be built safe distances apart, and other provisions are enforced by civil authorities who have control of building operations.

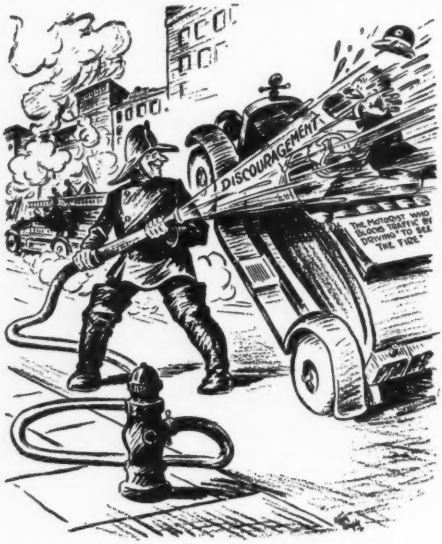
Such members as may resent having the good fire records of various European countries repeatedly flung up at them, may take comfort in noting that in the control of industrial hazards, for the prevention of which the elaborate regulations of the N.F.P.A. have been developed, Finland, like other European countries, is far behind the United States and Canada. One of the author's objects in coming to America was to study the standards by which we control the many hazards of our fast moving civilization so that similar standards may be introduced in Finland. But we can learn much from their building practices which have made the country safe from the spread of fire, even though it is largely built of wood.

* * * * * *

An Unusual Tank Truck Fire. An unusual gasoline tank truck fire in Oakland, California, is reported by Member Clarence Heller as further evidence of the need for the regulations on gasoline tank trucks which are now in course of preparation by the N.F.P.A. Committee on Flammable Liquids. QUARTERLY readers will recall that in the January, 1925, issue there was published a record of thirty-five tank truck fires and explosions causing a loss of twenty-seven lives, eighty-one injuries and property damage of more than half a million dollars.

The Oakland, California, fire which occurred on December 19 is of particular interest because of the unusual combination of circumstances involved. According to the report a passenger automobile collided with the rear of a gasoline tank truck containing 3375 gallons of gasoline, breaking off the spigot at the end of the delivery pipe. Gasoline flowed from the open end of the pipe. The driver of the truck endeavored to check the flow by stuffing rags into the pipe. He was partially successful, but in the meantime a large area of the pavement had been covered with gasoline. Shortly another automobile came into this area, skidding on the gasoline-wet pavement also crashed into the rear of the truck, breaking off the entire gasoline pipe. The liquid then poured from the truck, flowing on the streets for several blocks. The fire department was called and endeavored to flush the gasoline into the sewers, but before this operation could be completed the gasoline was mischievously set fire to by small boys and the streets for a space of nine blocks were a mass of flame. Four firemen were burned more or less seriously, three houses were ignited even though set back a considerable distance from the curb and the firing of a number of other houses was prevented only by the efforts of the fire department.

THIS MIGHT HELP!

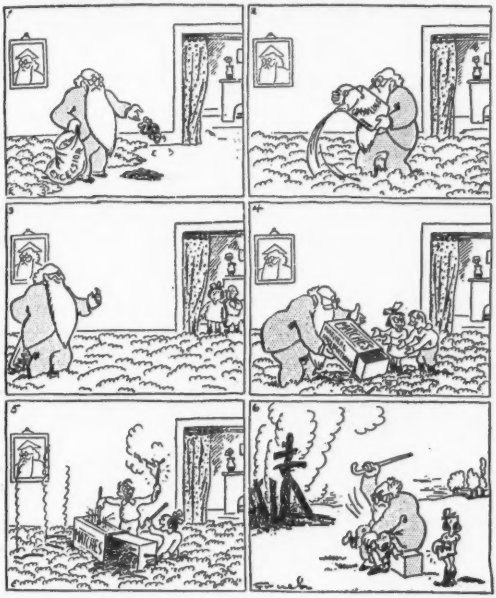


Keith Temple in the
New Orleans
Times-Picayune

Too Late Now

Paige in the
Utica (N. Y.)
Observer-Dispatch

The Story of Mankind, or, Iss Diss a System?



Frueh in
The New Yorker

PALS

Halliday in the
Providence *Journal*

Volunteer Firemen as Incendiaries.

Those complacent Americans who, because of the freedom and comfort enjoyed by them in our big republic, can live something like normal lives, and who through lack of philosophic insight assume that people like the Italians and Russians who permit government by dictatorship have different natures from our own, found what appeared to be confirmation of this notion in a recent cable to the New York Times, of which the following was the text:

Moscow, Nov. 19.—"Unless a man works neither shall he eat," runs the motto engraved on a stone obelisk facing the Moscow Soviet headquarters, and Bolshevists say it echoed across Russia and is sunk deep in every heart.

They may exaggerate, but at least it has reached the distant village of Shilka, near Chita, former capital of the defunct Far Eastern Republic. There it found response in the local Fire Brigade—four stout citizens, Martinof, Kochetkof, Golovanof and Kamenski.

With an antiquated hand pump outfit and a line of leaky hose their life was mighty hard in the Siberian village, and the firemen found that one fire every month or so at 25 cents an hour didn't feed their families.

They petitioned the village Soviet for a regular salary. The Soviet pointed out that fires were too infrequent to warrant such an expense. The firemen replied that this was due to their vigilance. The Soviet refused the petition.

Whereupon these firemen put into practice the Bolshevik motto and next month there occurred a dozen fires, each demanding four hours—at so much per head—to subdue.

The Soviet became suspicious and an investigation showed that the firemen were taking turns to "create" work. Accused of arson, all have confessed, mumbling in excuse, "Firemen can't live without fires."

Editorial comment on this dispatch agreed that while a policeman may be sometimes a crook a fireman as an incendiary is in our country a rarity. Both are obviously un-American. One newspaper poked a little sly fun at the *Times* correspondent's assumption that the legend on the Moscow obelisk is "Bolshevik," suggesting his perusal of American history which credits the motto "Unless a man works neither shall he eat" to Captain John Smith of the Virginia colony. It may even have been uttered by somebody before him.

As to the behavior of these four firemen in the little village of Shilka, while we may condemn them unreservedly as individuals, when we undertake to condemn them as Russians we may not be able wholly to avoid self-consciousness. On the authority of a no less distinguished person than Mr. F. R. Morgaridge, Assistant General Manager of the National Board of Fire Underwriters, this is a fairly well established American practice. Mr. Morgaridge, sometime deputy fire marshal of Illinois, is in charge of the arson work of the National Board and as completely informed on the ways of incendiaries as one could well be.

At the fire chiefs' convention in New Orleans in October, Mr. Morgaridge related an incident of American firemen that paralleled quite closely, except for the motive, the incident in Russia. In Rockville Center, a few weeks before, four members of the volunteer fire department had been convicted of arson, and sentenced to Sing-Sing. It appears that the city had purchased a new and expensive apparatus and it was undecided as to which of the seven companies was to get this new engine. It was finally decided to award it to the company making the best showing in the next few weeks. Gradually the Defender Hose Company began to monopolize matters. A sudden wave of fires gave plenty of opportunity for all, yet, in spite of everything the other companies could do, the Defender Hose Company seemed always in the lead. Then suddenly came the announcement that four members of this favorite company were under arrest, charged with setting fires, and as stated above, they were afterwards convicted.

Commenting on this general subject Mr. Morgaridge said:

"I presume that there are more pyromaniacs or individuals who set fires without any apparent cause in the volunteer fire departments of this country than in any other organizations of similar size. The same reason that prompts a man to join a volunteer fire department sometimes leads him to set fires. At times firemen set fires to enable them to pose as heroes in extinguishing them; to give them a chance to operate the new piece of up-to-date equipment that has recently been furnished them; sometimes the members of one company may set fires in the territory of another company so that they may demonstrate their alertness and their interest in safeguarding the property of the town by being first on the ground. I could cite innumerable instances of cases all over the country in which the members of volunteer fire departments have caused tremendous fire losses merely to satisfy some passing whim and create the opportunity for service to the city. I am, therefore, a strong adherent of the paid fire department."

Mr. Morgaridge emphasized the fact that these remarks should not be considered as an indiscriminate indictment of volunteer fire departments. He recognized the heroic work such departments are performing, their enthusiasm and efficiency, and said it was to be expected that members of these organizations should occasionally go wrong as men do who are engaged in other activities.

While Mr. Morgaridge did not mention in his address to the fire chiefs the pecuniary motive which induced the Russian firemen to go wrong he would no doubt be willing to admit that the practice of paying volunteer firemen for the hours of their actual service in fire fighting is wrong and has in more than one American town resulted in firemen increasing their wages by deliberately setting fires. Students of the modern school of psycho-analysis would find Mr. Morgaridge's observation that "the same impulse that prompts a man to join a volunteer fire department sometimes leads him to set fires" singularly acute.

1926 Fire Loss $393,020,500

In United States and Canada.

Fire losses in the United States and Canada reached the sum of $393,020,500 according to the figures compiled by the New York *Journal of Commerce* from their daily fire loss records. This is higher than the $373,500,550 loss in 1925, which dropped below the 1924 figure of $377,529,250, and is the highest since the 1922 peak of $410,889,350. In the last five years, according to the *Journal of Commerce* records, the total loss has been $1,944,131,850, averaging $388,826,370 annually.

Although the grand total for the year has increased there was a marked decrease in the monthly totals of the losses during the latter half of 1926, so that the year's poor record is largely due to bad losses in the early months. From July, the monthly losses decreased progressively, reaching the low figure of $19,309,000 in September, and dropping to $14,877,000 in October, the lowest record of any month for seven years. This is a decline unprecedented in any recent year, and suggests that organized fire prevention work is finally beginning to register, and gives good reason to hope for a marked reduction in the losses during 1927.

The monthly totals for the last three years show the unusual decline in the autumn months of 1926:

	1924	1925	1926
January	$41,243,600	$41,210,400	$41,118,750
February	31,447,900	32,472,000	30,963,750
March	28,406,150	33,346,500	42,854,600
April	31,815,900	37,696,800	52,408,400
May	27,832,300	29,170,800	32,764,200
June	20,350,400	23,650,800	28,676,000
July	23,968,800	29,622,000	31,723,400
August	31,349,000	23,348,750	27,833,400
September	29,612,400	25,396,250	19,309,000
October	27,944,400	23,991,250	14,877,000
November	39,081,600	30,320,000	26,724,400
December	44,476,800	43,275,000	43,757,600
Totals	$377,529,250	$373,500,550	$393,020,500

$9,639,609,245 Since 1879.

Fire record statistics year by year still show an appalling economic waste that only a profligate nation can tolerate. The fire losses of the past forty-eight as compiled from *The Journal of Commerce* records reach

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The fire loss figures of the *N. Y. Journal of Commerce* are based on estimates of fires involving loss of $10,000 or over, with a percentage added to cover small and unreported losses. These figures are not so accurate as, and are usually about a third smaller than, the statistics computed by the Actuarial Bureau of the National Board of Fire Underwriters which, because of the delays incident to compilation of complete records, are not published until later in the year. (The 1925 losses were given in the July, 1926, QUARTERLY, page 21.) The *Journal of Commerce* figures are immediately available, and valuable for purposes of comparison.—ED.

the vast sum of $9,639,609,245. The following table of the fire losses since 1879 gives some idea of the extent to which the resources of the country are wasted in fires we know to be largely preventable:

1926.....	$393,020,500	1910.....	234,470,650	1894.....	128,246,400
1925.....	373,500,550	1909.....	203,649,000	1893.....	156,445,875
1924.....	377,529,250	1908.....	238,562,250	1892.....	151,516,000
1923.....	389,192,200	1907.....	215,071,250	1891.....	143,764,000
1922.....	410,889,350	1906.....	459,710,000	1890.....	108,803,700
1921.....	332,654,950	1905.....	175,193,800	1889.....	123,046,800
1920.....	330,856,625	1904.....	252,554,050	1888.....	110,885,600
1919.....	269,000,775	1903.....	156,195,700	1887.....	120,283,000
1918.....	317,014,385	1902.....	149,260,850	1886.....	104,924,700
1917.....	267,273,140	1901.....	164,347,450	1885.....	102,818,700
1916.....	231,442,995	1900.....	163,362,250	1884.....	110,108,600
1915.....	182,836,200	1899.....	136,773,200	1883.....	110,149,000
1914.....	235,591,350	1898.....	119,650,500	1882.....	84,505,000
1913.....	224,728,350	1897.....	110,319,650	1881.....	81,280,000
1912.....	225,320,900	1896.....	115,655,500	1880.....	74,643,400
1911.....	234,337,250	1895.....	129,835,700	1879.....	77,703,700
Total, 48 years.....					$9,639,609,245

Large Loss Fires in 1926.

The following list shows twenty-two fires, during the year 1926, where the damage amounted to $1,000,000 or more, according to the estimates of the *Journal of Commerce.*

Month	Location	Description	Amount
January	Quebec, P. Q.	Hotel	$2,000,000
February	South Bend, Ind.	9 Retail Establishments	3,000,000
March	Newport, Ark.	20 Blocks, Dwellings and Factory	1,000,000
	Pittsburgh, Pa.	Power, Telephone and Construction Plant	1,000,000
	Frankfort, Ind.	Locomotive Shops	1,000,000
	New York, N. Y.	Steamship and Cargo	1,000,000
April	San Luis Obispo, Cal.	Oil Reservoirs	8,265,000
	Brea, Calif.	Oil Reservoirs	3,500,000
	Port Arthur, Texas	Tanker and Cargo	1,200,000
	Southeastern N. J.	Forest Fire	1,000,000
	Northern Minnesota	Prairie Fire	1,000,000
May	Caryville, Fla.	Lumber Plant	1,000,000
	Canton, Md.	2 Fertilizer Plants and Others	1,500,000
June	Lowell, Mass.	Department Store, Masonic Temple	1,000,000
	Lawton, Okla.	Ordnance Warehouse	1,000,000
July	Montana	500,000 Acres Timber Land	5,000,000
	Warren, Pa.	Refining Plant	1,250,000
September	New York, N. Y.	Yacht	1,100,000
October	San Francisco, Cal.	4 Lumber Mills	1,000,000
November	Beaumont, Texas	Oil Field Buildings	1,000,000
December	Paterson, N. J.	Silk Mills	1,000,000
	Three Sands, Okla.	Gasoline Plant	1,500,000

Fire Protection in Finland.

By Leo Pesonen, Secretary.

Fire Protection Association of Finland (Member N.F.P.A.).

Since many readers may know little about Finland, a short introduction may be necessary.

Finland is situated in Northern Europe between the Baltic Sea, the Arctic Ocean, Sweden and Russia. The area of the country is 149,404 square miles, and the population is at present about 3½ millions, thus the number of inhabitants is 23 to the square mile. Finland declared its independence in the year 1917, having been an autonomous State since 1809. It had its own legislature, its own administration and Parliament, its own political economy, courts of justice and other institutions, its own system of public education, a university founded in 1640, its own monetary system, its army, and even a customs line between Finland and Russia. These special privileges of Finland were seriously threatened by the Russian Government after 1899, but the Finns persistently defended their rights, and in the end freed their country from the Russian yoke through a short but bloody war after the defeat of the Muscovites in the World War.

Finland is a sparsely populated country, but is rich in forests and lakes. The majority of the people are farmers. The manufacturing industry is mainly derived from the production of timber. However, farm machinery, motor-engines, locomotives, ships, glass, shoes, textile materials, etc. are manufactured in the country. Cattle products, timber, woodpulp and paper are the most important exports. The cities are few and small. The population of the capital, Helsingfors, is 220,000. There are thirty-five towns in Finland. The smallest has 800 inhabitants. The country, with few exceptions, is sparsely inhabited. The distances are great. There are automobiles for transport purposes in the country districts, but their efficiency in the winter months is marred by the heavy snowfalls. Telephones, as well as electric light and power are in general use throughout the country.

The houses of most towns—particularly of the smaller ones—are generally built of wood, but at the beginning of the 19th Century there

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Author's Note: As Secretary of the Finnish Fire Protection Association, I spent last winter in America and am confident that what I learned during my visit will prove of considerable use to my own country, Finland. I should like to take this opportunity of heartily thanking all the Fire Chiefs and fire protection engineers I met for their courtesy and for all the information given me. May I say how heartily welcome they would be if they could pay a visit to Finland? L. P.

were several conflagrations, and after that strict orders were given regarding the construction of buildings. The wooden buildings in the smaller towns must be one-story buildings, and in the larger towns at most two-story buildings. Shingle and wooden roofs are prohibited. If a building is more than 4700 square feet in area it must be divided into two or more sections by fireproof walls. Eighteen feet is required between wooden buildings. The stone buildings are at most six-story buildings, the floors between the stories are usually, the staircases and the stairs always, "fireproof." Windows are not allowed to face a neighboring house. Between the two lots must be a fireproof wall without any doors or other openings. All architectural drawings must be approved by the local authorities before one may start building. A newly built house must be approved by the building authorities, before one is permitted to move in. The plans and any alterations of plans of the cities must be approved by the Interior Department. First aid fire appliances are required in every house and a fire inspection of the house is made yearly.

The results of these regulations have been extremely good. There have been no conflagrations for fifty years. Even fires which spread to the nearest neighboring houses are very uncommon. The last of this kind occurred ten years ago in Oulu, when four houses burned down.

Conditions in the Rural Districts.

The country, which generally is sparsely populated, has been without any organized safeguards against fire. Buildings are made of wood. The law provides against building nearer than fifteen feet from the adjoining lot. If the house is higher than thirty feet, the distance must be at least one half of the height. Hazardous buildings or plants may not be erected nearer than ninety feet from the neighboring premises. The method of building has not as yet been regulated, and lately with an increase of industry and traffic a great many districts have been built up, so that from the point of view of preventing fires, conditions are unsatisfactory. Recently the biggest fires have been in the country, in industrial establishments or in stockyards. The protection against fire in factories and stockyards depends mainly on the terms, tariff regulations and inspections of fire insurance companies.

There are laws on the protection against forest fires, on flammable liquids, and electrical plants. General fire regulations are being made.

Fires and Fire Losses.

In the whole country about 4,000 fires occur a year. Compensation for loss by fire, paid by fire insurance companies, amounts on an average to approximately 1¾ million dollars annually, or about 50 cents per head of the population. However, the loss is higher, since after the war the

The "Wall Street" of Helsingfors. Notice the uniform skyline. Height of buildings is seldom over six stories.

value of money has fallen and all the insurances have not yet been adjusted according to the new price level. Taking into consideration the change of money values and uninsured property the damage is approximately three million dollars.

Fire Departments.

There are fourteen permanent fire departments in the cities of Finland, fifteen semipermanent, and in addition in several cities and towns there is a volunteer reserve fire brigade. Many factories have good permanent or semipermanent fire brigades. General fire departments in the country are all volunteer. There are 200 altogether. The first volunteer fire brigade was founded in 1838. Most of the volunteer fire brigades are members of the General Fire Department Federation, which was founded in 1910.

The Finnish permanent fire departments are not organized into companies like the American. Fire stations are larger, so that a station can be manned even for response to two alarms, two or three automobiles responding to each alarm. Fire stations in the outskirts of the city are small watch-stations, to which men from the main station are detailed.

At a Finnish fire station one can find of course, an equipment room, a telegraph room, a gymnastic hall, a machine shop, a drying tower for hose, and a drill house. Family quarters for officers and underofficers, and mess rooms for men are also provided. The whole fire guard lives at the fire station. Men are enlisted in the same manner as seamen in the

The usual "first alarm" response from a Finnish fire station. Two 250-gallon pumpers and a ladder truck. Enough equipment and men are still in the station to respond to another call.

American navy. The wages are about the same as that of the police force. Fire departments are organized in a military fashion and a military discipline prevails. Every morning they have equipment exercises, and at noon gymnastics. All men are obliged to work in the work-shops of the fire department in which all repairing is done. Even new equipments are made. A fire department is utilized for first aid (ambulance) purposes and renders help in accidents, does duty in theatres, etc. Fire inspections are made by the officers. At most one-third of the men may be away on leave at the same time, and they must return to their duty if there is a big outbreak of fire.

The work is not particularly strenuous, because there are comparatively few fires. At nights only the station in the district in which the fire occurs is alarmed unless it is of such magnitude that assistance is necessary, in which case other stations will be called. In Helsingfors there are about 150 fires yearly of which 100 are extinguished without using the hose. In Turku (Abo), Tampere and Wiipuri there are about 50 to 75 fires annually, most of which are small.

Some information about the fire departments of the four largest cities in Finland will be interesting here.

HELSINGFORS. (*Population* 220,000.)

The Permanent Fire Department: 120 men. First fire station: 6 engine automobiles, 1 aerial-ladder automobile, and 2 automobiles for chief officers. Second fire station: 3 engine automobiles, and 1 aerial-ladder automobile. Ambulance station: 2 automobiles. There are also three watch stations, each one having a hose car.

A typical Finnish hose wagon which is the equipment provided for the small watch-stations in outlying districts of cities. No equipment other than this responds to first alarms at night, and other aid is seldom needed.

Volunteer Reserve Fire Brigade: 400 men, 1 engine automobile, 1 equipment automobile, 1 motor-engine in addition to hose equipments.

TURKU (ABO). (*Population* 45,000.)

The Permanent Fire Department: 63 men. Main fire station: 3 engine automobiles, 3 equipment automobiles, 1 aerial ladder, and 2 steam fire engines (in reserve). There are two watch stations each one having a hose car. A fire-boat of 1,000 gallons capacity.

Volunteer Fire Brigade: 650 men, 3 engine automobiles and 1 equipment automobile.

TAMPERE. (*Population* 50,000.)

The Permanent Fire Department: 41 men. One fire station, 2 engine automobiles, 2 equipment automobiles, 1 motor-engine, 1 aerial ladder, and 4 hose cars.

Volunteer Fire Brigade: 120 men, 1 engine automobile and 1 steam fire engine.

WIIPURI. (*Population* 45,000.)

The Permanent Fire Department: 55 men. Main fire station: 4 engine automobiles, 1 aerial ladder, 1 steam fire engine and 1 ambulance automobile. There are two watch stations, the one having an engine automobile and the other a hose cart.

Two Volunteer Fire Brigades: 250 men altogether. Each brigade has a steam engine.

Fire Equipments.

The equipments of fire departments are not as heavy as American equipments. The capacity of a fire engine is usually 250 gallons at a pressure of 100 to 120 lbs. The hose used by the fire engine is 3 inches in diameter, from which it is siamesed into three or four 2-inch branches. Couplings are of the snap type with ends interchangeable. Normally, nozzles are ⅜ to ½ inch in diameter, and the pressure is 40 to 70 lbs. If possible, enough lines of hose are used, that fires can be extinguished in all rooms at the same time. If the magnitude of the fire demands, the nozzles can be enlarged. Play pipes generally have three or four nozzles of different size, so the fire stream can be increased by unscrewing one or more of the nozzles. At big fires larger nozzles from 1 to 1¼ inches in diameter can be used direct with a 3 inch hose connected. Many of the fire brigades of the country are working with very modest equipments.

The Method of Extinguishing Fire.

Extinguishing fires—with few exceptions—is done from inside. For instance, during the last three years the fire department of Helsingfors has used aerial ladders only once, although most of the buildings are five or six-story stone buildings. All nozzles can be closed, and water is used very carefully. The hosemen move about very easily with a light hose, and can always select the best place for their work. There are no special hook and ladder companies, and the same officer conducts both the fire extinguishing and rescue work. Raincoats, rubber boots and salvage patrols are not used.

The Fire Protection Association.

To bring the fire protection work throughout the country up to date, and to be able to put an end to fires caused by carelessness, by the help of legislation, inspection and general educational work, the Fire Protection Association of Finland was founded in 1922, patterned after the National Fire Protection Association.

U. S. Supreme Court Upholds Zoning.

Municipal zoning ordinances are upheld in a decision of the United States Supreme Court rendered by Justice Sutherland on Nov. 22. This decision is of particular interest following as it does the discussion on Zoning at the last annual meeting of the N.F.P.A. (Proceedings 1926, page 79) during which reference was made to the then doubtful legal status of zoning in several states. This decision will be very helpful in the work of the newly created N.F.P.A. Committee on Zoning, of which Member Rudolph P. Miller is chairman.

Three judges (McReynolds, Butler and Van Devanter) dissented from the decision but filed no opinion. (*Village of Euclid, Ohio v. Ambler Realty Co.* on Appeal from Federal District Court for Northern Ohio, which had held the ordinance to be unconstitutional, as reported in 297 Fed. 307.) The opinion is directed particularly to the exclusion of business and industry from areas zoned as residential, never before ruled on by the United States Supreme Court, but in passing it upholds zoning in general as a proper exercise of the police power, stating that height limitations and certain use restrictions other than the one specifically ruled on in the Euclid case are already accepted as constitutional. The following extract from the text of the decision has been published by *Engineering News Record* (Member N.F.P.A.).

The Euclid Case.

The ordinance in question was adopted Nov. 13, 1922, by the village of Euclid, Ohio, a suburb of Cleveland, with a population of 2,363 in 1920. It divides the village into six use, three height, and four area districts. The Ambler Realty Co. is the owner of 68 acres of land abutting on Euclid Ave. to the south and the Nickel Plate R.R. to the north. To both the east and the west of this tract are "restricted residential plats upon which residences have been erected." Under the zoning ordinance the Ambler tract was distributed between three use districts: U-2, residential, for one-family or two-family houses only; U-3, residential also, but permitting apartment houses; U-6, industrial, within which most of the land in question lies.

The Ambler Realty Co., quoting now from the opinion, in its "bill" alleges "that the tract of land in question is vacant; that for years it has been held for sale and development, for which it is especially adapted, being immediately in the path of progressive industrial developments; that for such uses it has a market value of about $10,000 per acre, but if the

use be limited to residential purposes, the market value is not in excess of $2,500 per acre." The company also held that the Euclid Ave. frontage would have its value cut from $150 to $50 per front foot if limited to residential uses.

The suit was brought to set the entire ordinance aside as preventing the use of the land "for lawful and legitimate purposes," again to use the language of the decision, and because the ordinance "constitutes a cloud upon the land, reduces and destroys its value, and has the effect of diverting the normal industrial, commercial, and residential development thereof to other and less favorable locations." The company based its application for an injunction on the allegation that the ordinance violates Sec. 1 of the 14th Amendment of the federal constitution by depriving the company of liberty and property without due process of law, besides denying it the equal protection of the law. The company also claimed that the ordinance offends portions of the constitution of the state of Ohio.

In the lower court a motion was made on behalf of the village to dismiss the bill because the real estate company had made no attempt for relief from the Board of Zoning Appeals. The Supreme Court declares that "the motion was properly overruled."

The Supreme Court agrees with the lower court that, in the light of the record, the real estate company's land along Euclid Ave. would normally be used "for general trade and commercial purposes" while the remainder of the land would normally be used "for industrial and trade purposes." Nevertheless, the Supreme Court upholds the ordinance, even though it "in effect, constitutes a present invasion of appellee's property rights." The opinion disposes of allegations as to the ordinance violating the constitution of Ohio by saying that the question is the same under either the Ohio or the federal constitution. After pointing out that zoning laws are of recent origin and have come along with many other things due to urban growth that would not have been tolerated a century or perhaps a half century ago, but would have been rejected by the courts "as arbitrary and oppressive," it then says that such regulations are changed "under the complex conditions of our day, for reasons analogous to those which justify traffic regulations, which, before the advent of automobiles and rapid transit street railways, would have been condemned as fatally arbitrary and unreasonable." Continuing, the Supreme Court says:

> The ordinance now under review and all similar laws and regulations must find their justification in some aspect of the police power, asserted for the public welfare. The line which in this field separates the legitimate from the illegitimate assumption of power is not capable of precise delimitation. It varies with circumstances and conditions. A regulatory zoning ordinance, which would be clearly valid as applied to the great cities, might be clearly invalid as applied to rural communities.
>
> In solving doubts, the maxim *sic utere tuo ut alienum non laedas*, which lies

at the foundation of so much of the common law of nuisances, ordinarily will furnish a fairly helpful clew. And the law of nuisances, likewise, may be consulted, not for the purpose of controlling, but for the helpful aid of its analogies in the process of ascertaining the scope of the power. . . . A nuisance may be merely a right thing in the wrong place—like a pig in the parlor instead of the barnyard. If the validity of the legislative classification for zoning purposes be fairly debatable, the legislative judgment must be allowed to control.

After discussing at some length the municipal ordinance governing heights of buildings and excluding certain nuisance-producing and related industries from stipulated districts, all of which the Supreme Court says has been well established and gives citations to support the assertion, the decision goes on:

We find no difficulty in sustaining restrictions of the kind thus far reviewed. The serious question in the case arises over the provisions of the ordinance excluding from residential districts apartment houses, business houses, retail stores and shops, and other like establishments.

This question involves the validity of what is really the crux of the more recent zoning legislation, namely, the creation and maintenance of residential districts, from which business and trade of every sort, including hotels and apartment houses, are excluded. Upon that question this Court has not thus far spoken.

The decisions of the state courts are numerous and conflicting; but those which broadly sustain the power greatly outnumber those which deny it altogether or narrowly limit it; and it is very apparent that there is a constantly increasing tendency in the direction of the broader view. We shall not attempt to review these decisions at length, but content ourselves with citing a few as illustrative of all.

The Supreme Court opinion then cites the decisions upholding zoning in the courts of nine states—Massachusetts, Rhode Island, New York, Louisiana, Illinois, Wisconsin, Minnesota, Kansas, and California—and adverse decisions in three states—New Jersey, Maryland, and Texas. It notes "evidence of a decided trend toward the broader view" that in some states earlier decisions adverse to zoning have been reversed, mentioning Michigan. The opinion quotes at length from the Illinois Supreme Court decision (*City of Aurora v. Burns*) and from the Louisiana Supreme Court decision upholding zoning (*State v. City of New Orleans*). State decisions upholding zoning are summarized in the present opinion as follows:

The decisions enumerated in the first group cited above agree that the exclusion of buildings devoted to business, trade, etc.. from residential districts, bears a rational relation to the health and safety of the community. Some of the grounds for this conclusion are—promotion of the health and security from injury of children and others by separating dwelling houses from territory devoted to trade and industry; suppression and prevention of disorder; facilitating the extinguishment of fires and the enforcement of street traffic regulations and other general welfare ordinances; aiding the health and safety of the community by excluding from residential areas the confusion and danger of fire, contagion and disorder which in greater or less degree attach to the location of stores, shops and factories.

Another ground is that the construction and repair of streets may be rendered easier and less expensive by confining the greater part of the heavy traffic to the streets where business is carried on.

After stating that "Zoning has received much attention at the hands of commissions and experts" and referring to "comprehensive reports" on the subject the opinion continues:

These reports, which bear every evidence of painstaking consideration, concur in the view that the segregation of residential, business and industrial buildings will make it easier to provide fire apparatus suitable for the character and intensity of the development in each section; that it will increase the safety and security of home life; greatly tend to prevent street accidents, especially to children, by reducing the traffic and resulting confusion in residential sections; decrease noise and other conditions which produce or intensify nervous disorders; preserve a more favorable environment in which to rear children, etc.

With particular reference to apartment houses, it is pointed out that the development of detached house sections is greatly retarded by the coming of apartment houses, which has sometimes resulted in destroying the entire section for private house purposes, that in such sections very often the apartment house is a mere parasite constructed in order to take advantage of the open spaces and attractive surroundings created by the residential character of the district. Also, coming of one apartment house is followed by others, interfering by their height and bulk with the free circulation of air and monopolizing the rays of the sun which otherwise would fall upon the smaller homes, and bringing, as their necessary accomplishments, the disturbing noises incident to increased traffic and business, and the occupation, by means of moving and parked automobiles, of larger portions of the streets, thus detracting from their safety and depriving children of the privilege of quiet and open spaces for play, enjoyed by those in more favored localities—until, finally, the residential character of the neighborhood and its desirability as a place of detached residences are utterly destroyed.

Under these circumstances, apartment houses, which in a different environment would be not only entirely unobjectionable but highly desirable, come very near to being nuisances.

If these reasons, thus summarized, do not demonstrate the wisdom or sound policy in all respects of those restrictions which we have indicated as pertinent to the inquiry, at least, the reasons are sufficiently cogent to preclude us from saying, as it must be said before the ordinance can be declared unconstitutional, that such provisions are clearly arbitrary and unreasonable, having no substantial relation to the public health, safety, morals, or general welfare.

Considerable space is devoted to elucidating the principle that although a decision like the present one may uphold the general legality of an ordinance, yet some of its details might work injury which would demand relief, but such details must be left, the decision points out, to adjudication each on its merits. The decision then concludes as follows:

Under these circumstances, therefore, it is enough for us to determine, as we do, that the ordinance in its general scope and dominant features, so far as its provisions are here involved, is a valid exercise of authority, leaving other provisions to be dealt with as cases arise directly involving them.

And this is in accordance with the traditional policy of this Court. In the realm of constitutional law, especially, this Court has perceived the embarrassment which is likely to result from an attempt to formulate rules or decide questions beyond the necessities of the immediate issue.

It has preferred to follow the method of a gradual approach to the general by a systematically guarded application and extension of constitutional principles to particular cases as they arise, rather than by out of hand attempt to establish general rules to which future cases must be fitted. This process applies with peculiar force to the solution of questions arising under the due process clause of the Constitution as applied to the exercise of the flexible powers of police, with which we are here concerned.

G. Francis Kauffman, in *Collier's.*

Having read of the many fires started by discarded cigarette butts, Whiffleton tries the plan on his obstinate furnace.

Equipment for Fire Tests of Loaded Walls

By C. A. Menzel, Assistant Engineer.
Protection Dept., Underwriters' Laboratories (Member N.F.P.A.).

An interesting piece of equipment was recently designed and built under the direction of B. H. Glover (Member N.F.P.A.), equipment engineer, at Underwriters' Laboratories, by means of which bearing walls and partitions 10 ft. wide and 11 ft. high may be accurately loaded up to 500,000 lbs. while exposed to the action of a standard fire and subsequently to that of water streams. In the development of this loading equipment advantage was taken of the experience of the U. S. Bureau of Standards[1] with similar equipment designed for the same purpose.

The general arrangement of the equipment is represented in the accompanying sketch, which shows how the test wall panel is carried in a strong rectangular steel frame, hung from an overhead track in such a way that it can be drawn in front of a vertical gas furnace and exposed to the fire in its combustion chamber. The steel frame not only supports the wall panel but provides for subjecting it to a vertical load distributed along the entire length of the panel and for maintaining this load during the test.

Insulation of the frame is provided by brick masonry. The panel opening in this masonry frame is large enough to receive a test panel 10x11 ft., and leave a ¾-in. space on either side along the vertical edges to permit expansion or deflection of the test panel. Passage of flame through this clearance space is prevented by a packing of asbestos fiber or other suitable insulation.

Resting on the lower part of the supporting frame are 8 jacks spaced 15 in. apart, which carry a loading beam on which the test wall panel is built. At the top, the wall bears against the upper frame member. By applying hydraulic pressure to the jacks it thus is possible to load the wall as desired, up to the full capacity of the jacks. These have plungers 5½ in. in diameter by 6½-in. stroke; water is supplied by a motor-driven triplex pump in the basement, by way of piping controlled by bleeder or bypass valves as indicated. The pump, which has plungers ¾x6 in., is capable of delivering 1 gal. per min. at a pressure of 5,000 lb. per sq. in. The combined plunger area of the jacks is 190 sq. in., so that the test-frame capacity of 500,000 lb. is reached by a hydraulic pressure of 2,630 lb. per square inch.

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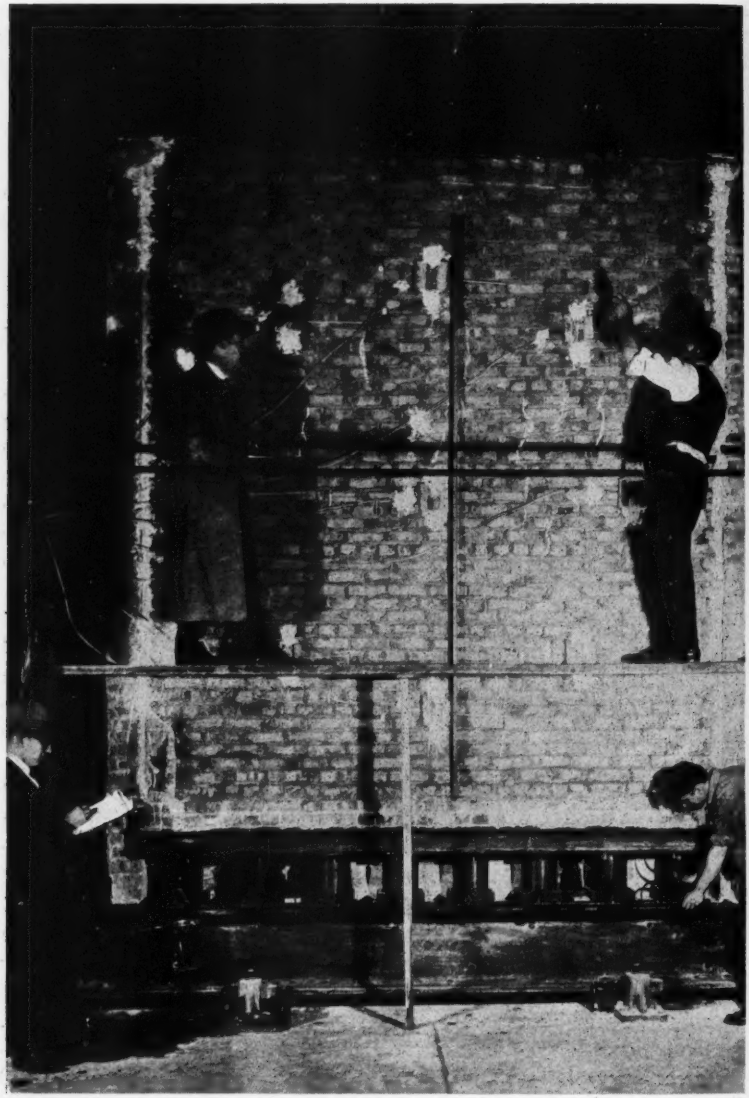
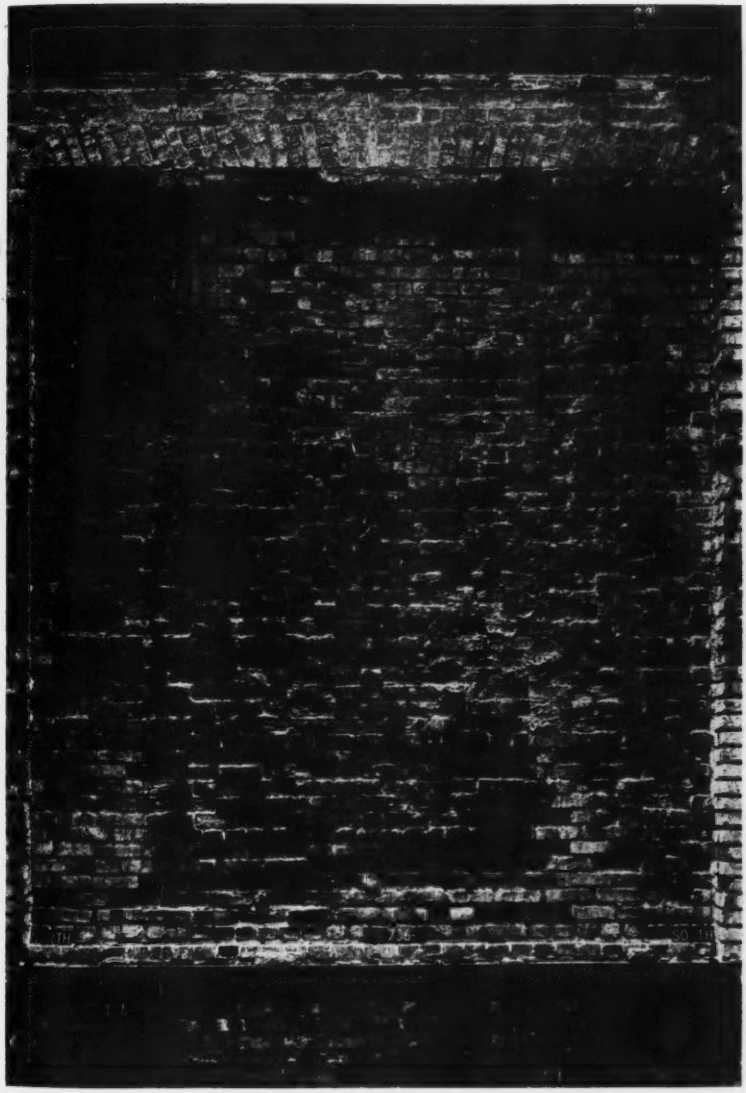
[1]The fire test apparatus of the Bureau of Standards and also some test results on brick walls were described in the January, 1924, QUARTERLY (Vol. 17, No. 3, p. 243) in an article, "Fire Tests of Brick Walls," by S. H. Ingberg.



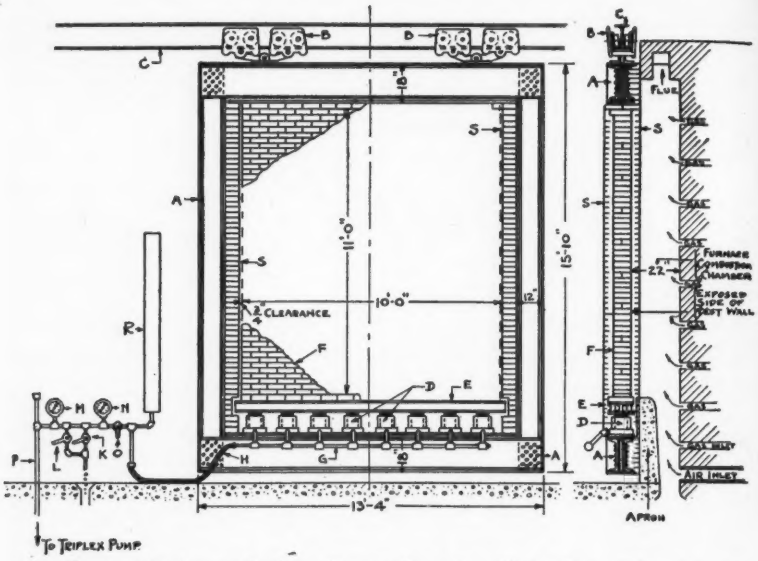
Courtesy *Laboratories' Data.*

The unexposed side of a wall set up in the apparatus and under test carrying a load of 163,000 lbs.



Courtesy *Laboratories' Data.*

The exposed side of a wall test panel after it had been subjected to the fire test under a load of 163,000 lbs., and then subjected to the impact, cooling and eroding of a water stream for 2¾ minutes.



General design and plan of operation of wall testing equipment at Underwriters' Laboratories.

As the fire-resistance time classification of a bearing wall or partition is contingent on the performance of two similar test samples, one subjected to a fire-endurance test under rated load, and the other to a fire-and-water test (fire exposure under rated load for one-half the fire-endurance period, but not to exceed 1 hr., followed by application of a standard fire stream to the incandescent inner face, this in turn followed after cooling but within 72 hr. by loading up to twice the rated load), two structural steel test frames are provided, so that both specimens of a wall test program can be built at the same time and tested in succession. A third frame, of lighter capacity (250,000 lb.), is provided for auxiliary service. Each frame has its individual supporting trolleys, but the same hydraulic jacks can be used in all of them, the jacks being portable.

The capacity of this equipment is ample for tests of solid masonry walls up to 12 in. thick. Views of an 8-in. brick wall during and after test are shown in the accompanying photographs. This wall was subjected to fire test while under a load of 163,000 lb. (170 lb. per sq. in. of bearing area) and immediately after removal from in front of the furnace was subjected for 2¾ min. to the cooling, impact, and eroding action of a water stream discharged from a 1⅛-in. nozzle 20 ft. from the wall under 30 lb. pressure. After cooling, the wall withstood a load of 400,000 lb.

The Value of Per Capita Statistics.

By H. L. Bond.
Field Engineer, N.F.P.A.

Per capita figures have been popular as a means of comparing the fire loss of nations, states, municipalities or any other territorial unit. Of course such figures are based on the assumption that for the same number of people there is the same proportional amount of things to burn. The wholesale application of this assumption has been sometimes challenged, as in the article by the late Charles E. Worthington entitled, "The Fallacy of Per Capita Loss Figures," in the October, 1923, QUARTERLY (Vol. 17, No. 2, page 130).

A recent study of per capita figures as applied to the dozen largest cities of the country indicates that the per capita method, while manifestly not absolutely exact in measuring the relative fire hazard or fire loss of any one of these cities, does nevertheless provide a fair means of comparison.

In these dozen cities the fire loss and the cost of operating the fire department have been compared. The real basis of comparison for the former item would be the ratio of the amount of material burned to the total amount available to burn. Likewise the expenditures on fire departments should rightly be compared to the amount and degree of the fire hazards protected. Of course, it is not possible to obtain any such measure as the above so we must be content with assuming that the amount available to burn, or the extent of the potential fire hazard is proportional to population or something else equally measurable. Some persons urge the use of the assessed valuation of a community as a measure of the burnable values existant therein, arguing that this is more exactly proportional to the amount of things to burn than population.

How far this may be true can be visualized from the table at the top of the next page. If Chicago and Los Angeles were left out of the above table it might be assumed that property values were approximately proportional to population. As it is, it shows that this is not necessarily true in *all* cases, but that other things being equal it will be true in *most* cases.

Figures on population and fire losses used in preparing this article are taken from the reports of the Committee on Statistics and Origin of Fires of the National Board of Fire Underwriters. Assessed valuations and costs of fire departments are taken from the reports of the U. S. Bureau of Census. Figures for the cost of fire departments in 1925 were compiled by the N.F.P.A. Executive Office. The Executive Office will appreciate notification of any omission or error which may have crept in due to the necessarily roundabout process of adapting the data from these original sources to the statistics presented.

THE TWELVE LARGEST CITIES OF THE UNITED STATES.

(Average for three-year period, 1923-1925, inclusive.)

City	Population (thousands)	Assessed Valuation (millions of dollars)
New York	5,939	11,956
Chicago	2,955	1,817
Philadelphia	1,958	3,673
Los Angeles	1,158	890[1]
Detroit	1,155	2,438
Cleveland	925	2,062
St. Louis	818	1,141
Baltimore	780	1,393
Boston	776	1,794
Pittsburgh	624	965
San Francisco	549	630[1]
Buffalo	540	764

[1]Two year average, 1925 figures not available.

The comparison conclusively demonstrates that there is a different basis for determining assessed valuations in different cities.

It is not surprising that the valuations for Boston, Cleveland, etc., are higher in comparison to their population than some of the other cities, but the cases of Chicago and Los Angeles need explanation. Chicago, with some four times the population of Boston, has nearly the same assessed valuation. Obviously, Chicago's property is underassessed as compared with the other cities, as there seems to be little occasion to question Chicago's population figure. The population figure for Los Angeles may not be accurate, however. The city has grown rapidly since the last census, and recent population estimates made by the city's Water Board indicate a considerably larger population than would be estimated by the usual Census Bureau practice, which assumes an annual increase in a city's population equal to the average annual increase during the preceding decade. It is possible, but not necessarily true, that Los Angeles population may be somewhat lower than the estimate of the Water Board used in the population figures given above.

Details of the fire losses of these twelve cities and their cost of operating their respective fire departments are presented in the four tables following. These tables are presented in more detail than is absolutely necessary for the purposes of this article. However, the details of fire losses and the costs of the fire departments will to certain readers be of more interest than the conclusions of the article itself. These readers may wish to observe the trend of the figures presented and speculate on the reasons why the fire losses may be much higher in certain cities than in others, and why it costs one city more than another to obtain a similar amount of fire protection.

ANNUAL FIRE LOSS.

Dollars Per Capita.

City	1925	Three-year Average 1923-1925 Inclusive	Ten-year Average Inclusive 1916-1925
Boston	6.97	7.11	5.02
Buffalo	5.79	5.35[4]	4.01[3 4]
St. Louis	3.95	3.85	3.56
Chicago	3.75	2.65	2.49
Pittsburgh	3.43	3.08	2.90[2]
Philadelphia	3.23	3.31	2.93
New York	3.21	3.23	2.82
Detroit	3.16	3.44	3.35
Cleveland	2.97	2.52	2.57
Baltimore	2.66	2.42	3.01[2]
Los Angeles	1.47	1.58	1.61
San Francisco[1]	...	...	...

[1]Fire department keeps no fire loss records. Record believed bad or poor. [2]Nine-year average. Figures for 1917 not reported. [3]Nine-year average. Figures for 1918 not reported. [4]1923 figure is for a seven-month period only. Annual loss figure probably higher.

ANNUAL FIRE LOSS.

Dollars per $1000 Assessed Valuation.

City	1925	Three-year Average 1923-1925 Inclusive	Ten-year Average 1916-1925 Inclusive[1]
Chicago	5.23	4.04	4.76
Buffalo	3.89	3.78	3.03[2]
Boston	2.93	3.09	2.39
St. Louis	2.72	2.75	2.96
Pittsburgh	2.14	1.99	1.94[3]
Los Angeles	...	2.13[4]	1.77[5]
Philadelphia	1.73	1.77	1.78[6]
New York	1.46	1.61	1.60
Baltimore	1.44	1.39	1.90[7]
Detroit	1.42	1.63	2.07[8]
Cleveland	1.28	1.13	1.32[6]
San Francisco[9]	...	...	...

[1]Average for 9 years over a 10-year period, no valuation figures for 1920 available. [2]Eight-year average, 1918 fire loss not reported. [3]Eight-year average, fire loss for 1917 not reported. [4]Average of 1923 and 1924 figures, no figure on 1925 valuation available. [5]Eight-year average, no figure on 1925 valuation available. [6]Eight-year average, 1916 figure on valuation not available. [7]Seven-year average, 1917 fire loss not reported and no figure on 1921 valuation available. [8]Eight-year average, no figure on 1921 valuation available. [9]Fire department keeps no fire loss records.

If the two cities which are known to be "erratic," Chicago with regard to its assessed valuation, and Los Angeles with regard to its population, are left out of consideration for a moment we might expect that the relative standing of the other cities would be about the same whether

ANNUAL COST OF FIRE DEPARTMENT.

Dollars Per Capita.

City	1925	Three-year Average 1923-1925 Inclusive	Ten-year Average 1916-1925 Inclusive[2]
San Francisco	$5.91	$5.29	$4.23
Boston	5.10	4.45	3.40
Buffalo	3.89	3.86	3.42
Detroit	3.88	3.42	2.59[3]
New York	3.71	3.26	2.41
Baltimore	3.58	3.02	2.21[3]
Pittsburgh	3.40	3.15	2.62
Los Angeles	2.99	2.86[1]	2.20
Cleveland	2.90	2.67	1.91[3]
St. Louis	2.41	2.32	1.97
Philadelphia	2.12	2.03	1.45
Chicago	2.03	1.99	1.68

[1]Average of 1923 and 1925 figures, 1924 cost not reported. [2]Costs for years 1920 and 1922 not compiled by Census Bureau. This is an eight-year average over a ten-year period. [3]Costs for 1921 not reported. This is a seven-year average.

ANNUAL COST OF FIRE DEPARTMENT.

Dollars per $1000 Assessed Valuation.

City	1925	Three-year Average 1923-1925 Inclusive	Ten-year Average 1916-1925 Inclusive[2]
San Francisco	...	4.32[1]	3.50
Los Angeles	...	3.75[3]	2.55
Chicago	3.24	3.22	3.38
Buffalo	2.61	2.73	2.73[4]
Boston	2.14	1.92	1.59
Pittsburgh	2.08	2.02	1.89[5]
Baltimore	1.93	1.73	1.43[4]
Detroit	1.75	1.60	1.55[6]
New York	1.67	1.60	1.31
St. Louis	1.66	1.66	1.85
Cleveland	1.25	1.20	1.03[4]
Philadelphia	1.07	1.09	.93

[1]Average of 1923 and 1924, 1925 figure for valuation not available. [2]Eight-year average over a ten-year period. Cost of departments not compiled by Census Bureau in 1920 and 1922. [3]1923 figure only, per capita cost not computed by Census Bureau in 1924, no 1925 valuation figure available. [4]Seven-year average, no 1918 valuation figure available. [5]Seven-year average, no 1917 valuation figure available. [6]Seven-year average, no 1921 cost reported to Census Bureau.

worked out on the basis of population or assessed valuation. The accompanying tables indicate that this is so. It is more clearly shown by the following tabulation which shows the relative standing of the cities without the numerical figures and with Chicago and Los Angeles omitted. San

Francisco is also omitted because no fire loss figures are available for comparison with the cost of the fire department which is the highest of the twelve cities.

RELATIVE STANDING 1925.

Fire Loss.		Cost of Fire Department.	
Per Capita	**Per $1000 Assessed Valuation**	**Per Capita**	**Per $1000 Assessed Valuation**
Boston	Buffalo	Boston	Buffalo
Buffalo	Boston	Buffalo	Boston
St. Louis	St. Louis	Detroit	Pittsburgh
Pittsburgh	Pittsburgh	New York	Baltimore
Philadelphia	Philadelphia	Baltimore	Detroit
New York	New York	Pittsburgh	New York
Detroit	Baltimore	Cleveland	St. Louis
Cleveland	Detroit	St. Louis	Cleveland
Baltimore	Cleveland	Philadelphia	Philadelphia

The relative standing of the cities is almost identical with regard to the fire loss, regardless of the base to which they are compared. There is a general correspondence in the positions of the cities with regard to the cost of their fire departments. This correspondence is less marked than in the preceding two columns and may be explained by the fact that the amount spent on the fire department is more largely governed by political considerations, expediency, funds available, efficiency of operation, etc., than on the values to be protected.

The foregoing study can be said to indicate the following: (a) that per capita figures are a fair index, in that they can ordinarily be depended on to show whether city's standing is high, average or low: (b) that they are a better index than figures given in relation to the assessed valuation of a city since valuation is assessed on a different basis in different cities.

Securing Support for the Fire Department.

By J. N. Speddy.
Chief of Fire Department, Lakewood, Ohio.

One of the most difficult problems that confront fire departments today, is the securing of sufficient funds to properly and efficiently operate.

Last winter, at a meeting of the officers and board of directors of the Ohio Fire Chiefs' Association, which was held in Lakewood, Ohio, one of the officers happened to see, lying on my desk, a tabulated list of the appropriation of funds for the different divisions of the fire department for the year 1926, and was evidently surprised at the amount, as he made the remark, "How do you do it?" and requested a copy of the budget for his own information.

I will endeavor to give such information as I can in regard to the methods we have used in Lakewood for a number of years past to secure this support and funds, which we believe have been fairly successful.

Since the organization of our department, we have endeavored to keep in mind that a fire department could be run on good business principles just as well as any other business or organization and today we have never seen any reason to cause us to change our opinion.

One of the most outstanding obstacles that prevent this accomplishment, is politics.

In order to prevent this, it is necessary for the department not to take part in any political questions of any description.

The merit system must govern, beginning with the applicant's entrance into the department and must continue during his term of service; in other words, the elimination of politics must begin with the department itself. The foundation is laid when the public learns that the department is governed by merit system only.

The continued hue and cry of the average citizen is for efficiency by public officials and the nearer you come to satisfying their demands, the better support your department will receive. In other words, it is simply a question of selling your fire department to your citizens by giving them the best possible service and this can only be accomplished by the intensive training of the members of the department, discipline, prompt and efficient service to the citizens to offset the general opinion of the public that a position in the fire department is a lazy man's job and that the department is made up of ne'er-do-wells or men who are failures in the average walk of life, which of course is not true.

From a paper read before the 1926 annual convention of the Ohio State Association of Fire Chiefs.

Every city or village usually has a number of public spirited citizens who take an interest in civic matters, a Chamber of Commerce, a Board of Trade, Rotary Club, Kiwanis Club and usually a number of fraternal organizations and last, but not least, public schools and in the larger communities, the newspapers. These various organizations are always interested in anything that is a benefit to the community. They serve and will usually get behind and boost any movement that has merit.

At the end of each year, funds received from taxation are appropriated for the operation of the entire municipality for the ensuing year. When these funds are ready for distribution, the question arises, what department needs it most and how will it be apportioned to each department of the city government? Men elected to public office usually will endeavor to do the things most spectacular to the public and will frequently favor one particular department, and as a consequence, some of the city departments will run short of funds.

In my opinion, very frequently, it is simply a question of salesmanship and the department head who can best sell the idea of the importance of his department to his superiors, is the fellow that usually obtains results.

The chief who sits back and thinks that "All comes to him who waits," ordinarily does not obtain very much consideration.

This point was brought, very forcibly, to my attention just before January 1 of last year, in one of the prominent cities in this State. While visiting this city during the holidays I read a newspaper article stating that this particular city was approximately fifty thousand dollars short in making up its budget for the coming year and it was suggested that the police department appropriation be cut accordingly. Immediately there was a great hue and cry against this, and this particular chief had so sold his department to his citizens, that their protest was of such effect that it was not done.

While in the city, I called on this chief of police, he being an old friend of mine, and as in the course of conversation this subject came up, he informed me that similar methods were used by his department to obtain the support of the public.

In support of this idea, the fact is that in our own state a great number of villages, of just a small population, are purchasing modern up-to-date fire fighting equipment, wherein a few years past, it was an unheard of proposition, so it is within reason to presume that maybe an apparatus salesman, a representative of the underwriters or the State Fire Marshal, in fact someone, sold them the idea, which is self evident that it is not an impossibility.

The average business man and home owner that make up a community is always interested in a "Dollar and Cents" proposition, in fact he can always talk in that language.

In order to place this matter intelligently before your community I would suggest that you request a survey to be made by the National Board of Fire Underwriters or by the insurance inspection bureau of the state depending of course upon the size of your municipality, which request is usually granted. You can also make a similar request of the State Fire Marshal to render such assistance as may be needed to present the matter before your own citizens, in order to obtain the necessary support, and usually they are only too pleased to grant your request.

After the survey is made by the underwriters, they will furnish you with a detailed list of recommendations and will show you in dollars and cents, the saving to your citizens in fire insurance ratings.

In this connection, it is well to bear in mind that in the case of a loss in a business of any description, fire insurance policies do not cover the loss of business or the loss in employees thrown out of employment in the case of fire and while the building is being rebuilt. Fire insurance policies do not cover the loss of the many keep-sakes in the home that are dear to the hearts of every person, the value of which cannot be measured in dollars and cents. In all of these cases, the loss of life that may be attendant in connection with a fire cannot be estimated in dollars and cents.

As a rule, public officials do not desire to be held accountable for the loss of lives and property that may occur for their failure to act upon recommendations made by recognized authorities upon the proper and continued presentation of facts.

The fire chief, who persistently places these facts before them and places himself on record, cannot be held responsible for the failure of public officials to present same to their citizens for their approval and then the failure of the citizens to vote and carry the bond issue.

Usually, public officials do not wish to hold the bag and will invariably be influenced by public opinion.

The mayor, safety and service directors and members of the councils, are usually very anxious and willing to listen to any constructive suggestions that will be beneficial to the citizens in the community in which they live, because that is the best kind of politics and they fear adverse public opinion.

To illustrate the point in question, referring to an article written recently by a very prominent man, which I have paraphrased to apply to fire departments. "Breaks come to the chief who goes out and makes them. Getting the breaks is just a matter of a chief keeping his head up and staying in the game every minute without a let-up. I don't care who the chiefs are, big or little, the fellows who keep their heads up and keep trying, are the fellows who get the breaks. They are the fellows who win in the game."

Fire Tests of Office Occupancies.

At U. S. Bureau of Standards.

The Fire Resistance Section of the United States Bureau of Standards has been for some time engaged in conducting a series of tests to determine the intensity and duration of fires in buildings of various occupancies. The test program is not as yet concluded and only a partial report can be made on the tests thus far conducted, but it is thought that information now available should be published without awaiting the completion of this research.

The tests to obtain information on the intensity and duration of fires in buildings are conducted to determine the temperatures to which it is proper to subject building materials and constructions in fire test furnaces and to serve as a guide in applying the results of such furnace tests to building design. In the test furnaces walls, partitions, floors, doors and windows are subjected to a controlled test fire reaching certain intensities at given times after the start of the test, the result being expressed in a time-endurance unit or period which is the length of time the construction withstands the test fire without failure or dangerous weakness. The burning out tests give information relative to the propriety of the fire intensities employed in the test furnaces and indicate for what building types and occupancies constructions are adequate that have withstood the regular fire tests for given periods.

A previous preliminary report on this test work was published in the QUARTERLY for January, 1926 (Vol. 19, No. 3, page 235), in which the test equipment was described and illustrations given of a fire test representing a typical record room occupancy. These first tests were made in a one-story brick and concrete building about 16x30 feet in floor area. It has been felt that tests in this structure may not give representative results because the size of the undivided area involved in a fire may have an important effect on its intensity and duration. Accordingly a larger building measuring 30x60 feet, inside dimensions, was constructed. The fire tests referred to in this article were conducted in these two buildings.

Tests were conducted in both of the buildings with contents representing a typical record storage or reference room which is considered as creating the severest fires in office buildings. It is not as yet possible

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The data for this article has been taken from the Technical News Bulletin of the U. S. Bureau of Standards, which together with the photographs are made available through the courtesy of Mr. S. H. Ingberg (Member N.F.P.A.).

Fig. 1. Interior of the test building (room 30x60 feet) prior to the start of the office occupancy test fire with wood furniture on a wooden floor. The combustible contents of this room, including the wooden flooring, averaged 18.7 lbs. per sq. ft., representing nearly the maximum of combustible material for ordinary office occupancy.

to publish any conclusions based on these record room fires beyond that they are of considerably greater intensity and duration than those in the ordinary office occupancy. It is proposed to conduct further tests with residential and warehouse occupancies in order to cover the range of conditions encountered in fires in buildings. Reports on these together with additional data on the earlier tests will be published at a later date.

Office Occupancy With Wood Furniture.

In the present test with office occupancy the weight of wood furniture, consisting mainly of old desks, tables, filing cabinets, and bookcases, was 13,650 pounds, giving a weight of 7.58 lbs. per sq. ft., the test house being 30 by 60 feet in inside lateral dimensions. The weight of the paper contents of the files and other furniture was 14,100 pounds (7.84 lbs. per sq. ft.) which, together with that of the furniture and the wood floor and sleepers, gave a total combustible weight of 18.7 lbs. per sq. ft., of floor area. This was higher by about 30 per cent than that present in previous tests with office occupancy in the smaller structure and can be taken as near the upper limit for the regular occupancy as such, although weights

Fig. 2. Exterior of the test building during the fire test of office occupancy with wood furniture (see Fig. 1). During this fire the maximum temperature reading inside the building was 2088° F., the maximum temperature at any point being reached within approximately one hour after the general ignition of the contents in that vicinity.

in record storage rooms may go higher. The fire was started in the furniture at several points near one end as might occur where fire is communicated from an adjacent burning building. On account of the large room size it was not practicable to obtain the exposure start used in some tests in the smaller structure, by burning readily combustible material in a large grate in one corner, which, when its inclosure was drawn back, quickly built up temperatures within the smaller room high enough to cause ignition of combustibles over a large portion of the room. In the present test the temperature needed to cause rapid spread of the fire had to be built up from the fire in the furniture, which required about one hour, during which time the fire was confined to the furniture within 15 feet from the end where the fire was started. The average temperature in this end was near 425° C. (797° F.) at one hour after the fire was started, although temperatures as high as 750° C. (1,382° F.) obtained near burning pieces of furniture. The average temperature in the opposite end of the 60-foot room was at this time 215° C. (419° F.). From this time on the fire spread rapidly, reaching the opposite end of the room within 30 minutes. The temperatures in given sections of the room

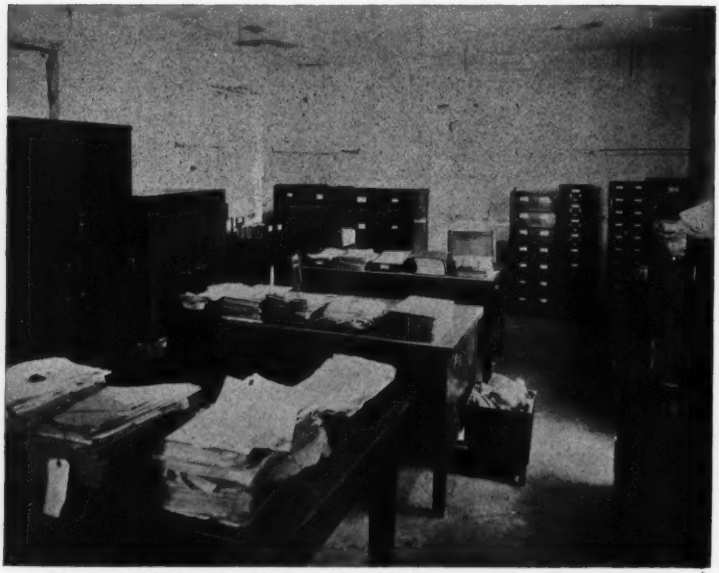


Fig. 3. Office occupancy with metal furniture on a cement floor. This fire was given a slow start, the papers in a large metal wastebasket being ignited. The exposed papers were considered as representing the probable maximum of exposed combustible material in an occupancy of this character.

reached their maximums within one hour after general ignition of contents occurred in the given section. These maximum temperatures were generally higher than in previous tests with office occupancy, all thermocouples registering at some time temperatures over 900° C. (1,652° F.) and over one-half of the number, temperatures over 1,000° C. (1,832° F.). Eighteen of the one hundred and seven thermocouples indicating room air temperatures rose to maximums above 1,100° C. (2,012° F.), the maximum reading for any point during the test being 1,142° C. (2,088° F.).

After the maximum intensity was passed the room temperatures fell slowly, between two and three hours being required before they were below values that might impair the strength of structural members. This rate of cooling is less rapid than those obtaining in test furnaces after the fire is shut off, and pending further study of the temperature data no definite statement can be made as to the equivalent in hours of test furnace exposure of the fire conditions created in this test. During this test the window shutters were opened by an amount deemed sufficient to give the maximum fire intensity when the fire was at its height and left at such openings while the interior cooled down.

Fig. 4. Results of the test fire with metal furniture on a cement floor (see Fig. 3). The first attempt to ignite this material by a wastebasket fire was unsuccessful, but at the second attempt the exposed papers were ignited with the results shown above. Only 150 pounds of exposed records were burned or charred, the balance of the 3900 pounds of paper in the room being unaffected.

Fire Tests of Office Occupancy With Metal Furniture.

These tests were made in the smaller structure having 15 by 29 feet floor area. The metal furniture consisted of 2 desks, 3 tables, 3 open shelving units, 1 stationery cabinet, 1 light walled filing safe, and 17 filing cabinets 51 to 59 inches high, which, with chairs and minor equipment, gave a weight of 13.3 lbs. per sq. ft as assumed uniformly distributed. The furniture was supplied through the National Association of Steel Furniture Manufacturers. For the tests with cement finish floor the weight of paper contents placed in and on top of the furniture was 3,900 pounds, or 8.83 lbs. per sq. ft. of floor area. Two open shelving units, one 6 feet wide and 8 feet high and another 5 feet wide and 3 feet high, the latter placed on a table, were located near the origin of the fire in all tests. A considerable amount of exposed paper was placed on top of desks and tables, three file and desk drawers were left open, also one door of the stationery cabinet. The total amount of records present was greater by about 25 per cent than the average obtaining in four previous tests with wood furniture. About 55 per cent of the records were not contained within closed drawers or cabinets.

Fig. 5. Fire test of metal furniture on wood floor arranged for slow start of fire. The fire in this case was started in the wastebasket and loose papers shown in the background at the left of the picture. The character of the contents, with the exception of the wooden floor, was not materially different from that in the preceding test (Figs. 3 and 4).

In the first test with slow start, the fire, started in a large metal waste paper basket placed between the open shelving units, failed to ignite the exposed papers. In the second trial the papers on portions of the two open shelves and on one table immediately adjacent to the fire origin were ignited but the fire did not spread, and at one and one-fourth hours only faint flames and glowing of exposed papers were apparent. The highest room temperature reading was 104° C. (219° F.), which was at 35 minutes after start of fire, immediately above the burning paper. The average indicated temperature in this end of the room was at this time 54° C. (129° F.). Only 150 pounds of exposed records were burnt or charred in whole or part.

The affected paper was replaced with unexposed stock and the exposure grate located in one corner of the room filled with 424 pounds of pine kindling saturated with 1 gallon of kerosene. The grate was 3 feet 2 inches in diameter and 6 feet 7 inches high, the sheet metal shield around it being withdrawn when the kindling was fully ablaze. In the previous exposure starts with wood furniture, less material (240 to 250 pounds) was placed in the grate, as the furniture burning near it con-

Fig. 6. Results of the fire test with metal furniture on wooden floor with slow start. This fire starting in the wastebasket in the rear of the room ignited nearby papers and the wooden floor. The material on top of the desks in the foreground was not affected nor was the contents of the nearby wastebasket ignited. The contents of the filing cases with bases extending to the floor were generally ignited, from forty to sixty per cent of their contents being made illegible.

tributed sufficiently to the fire to cause spread with the smaller amount of fuel. In the present test a high enough temperature was built up to cause ignition of exposed papers for a 20-foot distance along the center of the room and for 10 to 15 feet along the side walls. The temperature maximums at different points in the room occurred between 5 and 15 minutes after the blast of flame and hot gases was liberated, most of the heat developed being from the fuel in the grate. At the end of this period the room temperatures were generally below points causing ignition of combustible materials. During the initial period the temperature maximums in the end of the room where the fire started ranged from 146 to 808° C. (295 to 1,486° F.) and in the opposite end from 55 to 542° C. (131 to 1,008° F.). One-half hour later the exposure start the average room temperature was below 150° C. (302° F.) and the maximum indicated for any point was 226° C. (439° F.) which latter was immediately above the grate. At one hour the average was below 100° C. (212° F.) and the maximum 194° C. (381° F.). The exposed papers and linoleum desk and table tops within 10 feet from the grate along the sides of the

Fig. 7. Metal furniture on wood floor before exposure fire start. The contents and arrangement in this test were substantially the same as in the preceding test (see Figs. 5 and 6). The fire was started under conditions representing an exposure fire. The pile of kindling in the background was enclosed by the sheet metal shield, was thoroughly ignited and when burning at maximum intensity the shield was removed.

room and within 16 feet from the grate in the central portion of the room were consumed. Where not affected by burning of exposed papers and linoleum immediately on top, contents of closed file and desk drawers, where more than 5 feet from the grate, exhibited practically full legibility. For the room as a whole between 2 and 3 per cent of the records within closed containers were made illegible in the ordinary sense. Some of the charred papers classed as illegible could be read if carefully handled.

Metal Furniture, Wood Floor, Slow Fire Start.

All affected paper was replaced, as also the burnt top coverings of tables and desks, and a three-fourths-inch pine top floor on 2 by 3 inch sleepers in dry cinder fill placed over the concrete floor. Furniture and contents were arranged as for previous tests, except that the amount of exposed paper was decreased by 400 pounds which, with other minor changes, gave a record content of 3,420 pounds and with the wood flooring a total combustible content of 11.9 lbs. per sq. ft. of floor area. In the first test with the wood floor the fire was given a slow start in a pile of waste paper at the same point from which fire was stated in previous tests. Fire was communicated to the papers on the adjacent large open

Fig. 8. After the fire test with metal furniture on wood floor with exposure start (see Fig. 7). The average maximum room temperatures obtained here were higher than the previous tests with metal furniture, ranging from 759 to 1625° F. The contents of all tables, desks and open shelves were consumed or charred beyond legibility.

shelving units and to the papers on top of the table supporting one of them. The progress of the flames was not rapid, over one hour being required for the fire to spread to all parts of the large open shelf. The fire in the wood floor also spread slowly, about 30 per cent of the floor being consumed eight hours after the fire was started. The fire in the floor was stopped at this stage. No decided rise in room temperatures occurred, the maximum reading at the different points ranging from 50 to 230° C. (122 to 446° F.), the temperatures for only two locations being at any time barely high enough to ignite combustible materials. The papers in drawers and on top of a desk and a table, beneath which the wood floor was burnt out, did not ignite, nor did the contents of waste-paper baskets ignite, the bottoms of which were supported above the burning floor on metal legs from 1¾ to 2½ inches high, although the papers near the bottom were decidedly charred. The filing cabinets within the burnt area had sheet metal bases extending to the floor and their contents were generally ignited, from 40 to 60 per cent of the contents of four-drawer cabinets being made illegible by the floor fire. The contents of one corner cabinet, under which one-half of the floor and one-half of the adjacent baseboard burnt out, were not ignited.

Metal Furniture, Wood Floor, Exposure Fire Start.

The burnt portion of the floor and affected records were again replaced and the grate charged with 350 pounds of pine kindling which, saturated with kerosene, was ignited and the grate shield operated to give an exposure start for the fire. About the same extent of initial spread took place as in the exposure start with the cement finished floor. The fire in the wood floor progressed more rapidly than with the slow start for the fire, being about 20 inches from the opposite end of the room at four hours, when the fire was put out. The average maximum room temperatures attained were higher than in previous tests, maximums from 404 to 885° C. (759 to 1,625° F.) occurring during the first hour in the end of the building where the fire started. In the opposite end the temperature maximums ranged from 265 to 570° C. (509 to 1,058° F.) at three hours after the start of the test. The higher temperatures obtained only for a short time adjacent to the grate and after 15 minutes no temperatures over 570° C. (1,058° F.) were recorded, and readings at only three points indicated temperatures over 450° C. (842° F.). The exposure generally was not sufficiently severe in intensity and duration to impair the strength of structural members having the minimum of protection incident with fire-resistive construction. Room temperatures above the ignition points of combustible materials were, however, maintained by the burning of flooring and exposed records, for over three hours. The contents of all tables, desks, and open shelves as well as all exposed papers were consumed or charred beyond legibility. The contents of two filing cabinets in the end near the grate were almost completely charred and rendered illegible. In the case of other cabinets, including the filing safe, under which the floor had burnt out, the legibility of contents ranged from 15 to 80 per cent, and where the floor under the cabinet was partly or fully intact the legibility ranged from 75 to 100 per cent. Water was applied after between four and five hours, hence the data do not give information on the amount of damage to records if the fire had been allowed to burn itself out.

It is intended to repeat the tests with metal furniture with a minimum amount of exposed paper, the test conditions in the test described being representative of the maximum amounts that may be present. It is also intended to use hardwood top flooring in place of the pine used in the present tests as this might make a difference in the spread of the floor fire and its intensity. It is also intended to study in more detail the effect of base details of filing cabinets on the susceptibility of contents to ignition from a floor fire.

It is apparent that the results of these tests apply only where the occupancy is housed in a fire-resistive building where floor, bearing walls, or columns do not collapse as a result of the fire.

Safe Methods of Moth Control.

Complete elimination of moths is difficult. They breed in wearing apparel, carpets, rugs, upholstered furniture, etc., and a single infested article may furnish a steady supply of moths to keep a house stocked. Many of the popular methods of moth control involve serious fire hazards and for this reason this subject will be of interest to QUARTERLY readers. Recently the Bureau of Entomology of the U. S. Department of Agriculture issued a bulletin describing various methods by which moths can be controlled.[1] This article includes a description of the several safe methods as given in the bulletin, and a criticism of the other methods mentioned which are hazardous from a fire standpoint.

Among fabric pests, clothes moths are the prime offenders. It is not the moths or millers which are commonly observed that feed on and destroy the fabrics. Their purpose in life is to lay eggs that develop into the larvae or worms. Killing these moths, however, prevents their laying any more eggs.

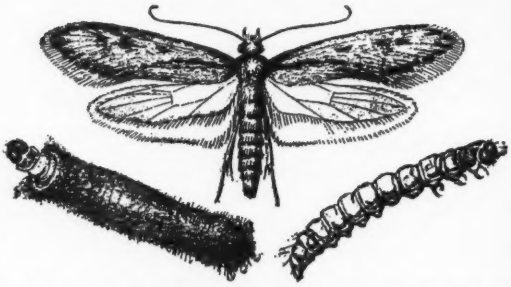
The moths lay their eggs in and about clothing and other objects subject to attack. From the eggs are hatched the larvae, or worms. When these become fully grown, they are whitish and about half an inch long. The larvae spin cocoons in which they transform to the pupa or chrysalis stage, and during this stage the insect changes to the adult, or moth. Thus each generation of clothes moths passes through four distinct stages, namely, the egg, the larva or worm, the pupa or chrysalis, and the adult or moth. Only the worm or larva of the clothes moth is capable of destroying fabrics.

Common Species of Clothes Moths.

There are two very common species of clothes moth. They are the "case-making" clothes moth and the "webbing" clothes moth. A third variety, called the "tapestry" moth is less common. The first of these is so named because the larvae for protection make a portable case out of spun silk and the fabric on which they feed. The larvae drag this case about restlessly eating small holes here and there. The webbing moth is the most abundant and injurious species. Its larvae are much like the case-making moth's but they make no portable case, being content to spin silky transparent tunnels or tubes wherever they go. The tapestry moth's larvae is noted for its preference for coarser and heavier fabrics than the

[1]United States Department of Agriculture, Farmers' Bulletin No. 1353, Clothes Moths and Their Control, by E. A. Back, Entomologist in charge of Stored Product Insect Investigations, Bureau of Entomology.

other two species. They construct burrows or silk-lined galleries in all directions throughout the infested material and often cause quite as much injury by these as by the amount of fabric that is actually eaten.



An enlarged drawing of the "case-making" species of clothes moth. Above, is the adult; at the right the larva; and at the left the larva in the case peculiar to this kind. The other varieties are very similar except that their larvae make no case.

Clothes moths feed upon wool, fur, hair, feathers, and all fabrics manufactured from them. They also relish dried animal matter such as dead insects, including the dead of their own species, and untreated skins, beef, meal, casein, etc. When a campaign is waged against clothes moths in the home, it must be remembered that they may be found feeding upon carpets and rugs, stuffing and covering of upholstered furniture, tapestries, stuffed animals or birds, dust brushes, shaving brushes, the felts in pianos, and a long array of articles often little thought of as being fed upon by clothes moths. Clothes moths almost never injure household fabrics or wearing apparel in daily or weekly use, or articles that are brushed, cleaned, or beaten once or twice a month. Furniture, on the other hand, may be in constant use and still be badly infested.

The adult moth or miller has a brief life of about a month but in this time lays as many as 150 eggs, placing them snugly down in the fabric or fur. These eggs hatch into larvae in from four days to three weeks, depending on the temperature. It is in the larvae stage, during which damage to fabrics is done, that the growth of the moth is most affected by changes in temperature, its food or the humidity. When first hatched the larvae is white, as when full grown, and is scarcely one-sixteenth inch long. When full grown it may be half an inch long, although its size will depend on its environment and its food supply. This may make the life of the larvae range from four to ten months, during which it is constantly feeding. Its progress through the pupa or chrysalis stage takes from one to three weeks.

A List of Control Methods.

The U. S. Department of Agriculture suggests a variety of methods to control these pests. They report that the following methods have been

thoroughly tested and are in general use by the public. They recommend these methods without reservation if used with an intelligent understanding of their good and bad features and in accordance with directions.

(1) Constant watchfulness. This must be the watchword for successful control. No treatment known to kill clothes moths already in fabrics will have any lasting effect in keeping other clothes moths from infesting the fabrics later if they are left exposed about the house. There is no treatment known that is practical that will render wearing apparel absolutely immune to attack.

(2) Thorough brushing, beating, and, if possible, sunning fabrics before any treatment is applied. These are important under all circumstances.

(3) Careful wrapping in unbroken paper.

(4) Naphthalene. Very effective in the form of flakes or moth balls for protecting clothing in closets, trunks, and tight chests.

(5) Paradichlorobenzene. Equal in effectiveness to naphthalene and used in the same manner.

(6) Camphor. For use in tight chests and trunks, but not as good as naphthalene and paradichlorobenzene.

(7) Pyrethrum powder. Not as good as either naphthalene, paradichlorobenzene or camphor.

(8) Cold storage. Rather expensive, but a certain method of protection against clothes-moth injury during the period in storage.

(9) Hydrocyanic-acid gas. Excellent for fumigating entire houses or single *tightly sealed* rooms, but dangerous except when applied by an expert or careful and well-informed person.

(10) Sulphur fumes. Sulphur fumes generated by burning sulphur candles, purchased at drug stores. Likely to bleach wall paper and fabrics and will tarnish metals.

(11) Carbon disulphide. Excellent for fumigation of closets which can be tightly sealed, trunks, chests, and other tight containers. The gas is flammable.

(12) Carbon tetrachloride. Excellent for fumigation of single rooms, closets, trunks, chests, and other tight containers.

(13) Cedar chests. Excellent for protecting clothing if used according to directions.

(14) Dry heat. Dependable if it can be applied.

(15) Hot water.

(16) Soap solution.

(17) Treatment of cracks and hiding places with gasoline, benzene, and kerosene.

(18) Dry cleaning.

There are some very real objections from a safety and fire prevention viewpoint to several of the methods recommended. Naphthalene, used in this way, may be a hazard. Certainly its vapor is flammable, and the substance is considered dangerous. It is rated as one of the most effective methods of controlling moths, but no more effective than the use of paradichlorobenzene, which is equally convenient and practical, while at the same time presenting no fire hazard. Camphor has objections similar to naphthalene.

Fumes from sulphur candles are indicated as a practical means of

fumigation and much safer than the use of hydrocyanic-acid gas. The use of these candles of course introduces a fire hazard.

Both carbon disulphide and carbon tetrachloride are recommended for fumigation of closets, small rooms, chests, etc. They are said to be about equally effective, except that a larger quantity of carbon tetrachloride is needed to do the same work as carbon disulphide. This means that there is no need to recommend carbon disulphide, the vapor of which is highly flammable, and the liquid of which produces a fire very difficult to fight. (See Extinguishing Carbon Bisulphide Fires, page 279.)

The treatment of cracks and hiding places with gasoline, benzine, and kerosene seems to unnecessarily create an hazard. The bulletin in which the advice is given warns against "the careless use of these materials because of their flammable nature," and also points out that where thorough fumigation is employed, this laborious treatment is unnecessary.

Dry cleaning is recommended, which is good advice provided no attempt is made to do dry cleaning in the home. The Department of Agriculture is to be commended for including a distinct warning against spraying garments with, or dipping them in gasoline, saying that while gasoline is somewhat effective in destroying larvae, the method is impractical because of the fire hazard involved.

Safe Procedures.

Too much emphasis can not be placed on the value of frequent brushing, beating, sunning, and cleaning of articles subject to clothes-moth attack. The eggs of clothes moths are delicate and can usually be crushed or dislodged by brushing and beating and this will usually kill the larvae as well. Pay special attention to crevices, seams, and pockets. Sunning is a valuable aid in control work. In articles laid away moths are much more likely to concentrate upon soiled spots if these have not been removed. If clothing is thoroughly brushed every two weeks, it is doubtful if moths can affect it seriously. Clothing dry-cleaned is also freed from infestation by the process.

Once freed from infestation, clothes should be protected, if they are not to be used during the warm season, by being wrapped in paper or placed in tight chests or treated closets. The public is familiar with "moth-proof" paper bags of various types that appear upon the market each summer. These paper bags for the storage of suits and coats are made of heavy paper, paper impregnated with tar, or other substances for which much is claimed. These bags if not torn and if properly used are excellent for keeping moths from reaching clothing. They are of no value in killing moths that may be in the clothing when it is placed in the bag, and those made of plain paper are just as good as those containing tar.

Ordinary firm wrapping paper is satisfactory, or several thicknesses of newspapers will serve. Any paper of moderate thickness and unbroken will protect clothing. Care must be exercised to bend back the folds of the paper upon themselves at the ends of the bundles so that the moths can not crawl into the bundles at the ends. Hats and other articles that will be damaged by tight wrapping can be protected by placing them in ordinary unbroken cardboard boxes, hat boxes, etc., and then sealing the covers of the boxes with gummed paper. After clothing has been made into bundles or sealed in boxes, these bundles and boxes may be left exposed in garrets or on storeroom shelves without danger of infestation from without.

Paradichlorobenzene.

Paradichlorobenzene is a white crystalline substance, which vaporizes slowly at ordinary temperatures, forming a gas apparently heavier than air. This gas is nonpoisonous to man, but poisonous to clothes moths and other fabric pests when they are exposed to it in tight containers. The fumes do not injure fabrics. Paradichlorobenzene is similar in general appearance to naphthalene flakes. It can be purchased in tin cans containing from 1 to 10 pounds, from drug stores or direct from the manufacturing chemists, at a cost of from 15 to 45 cents per pound, according to the quantity purchased. It appears to be quite as effective as naphthalene and while a relatively new remedy it bids fair to become equally well known in moth control.

To get definite results it must be used in tight chests, trunks, or other containers where the fumes given off by the slow evaporation of the crystals will be confined. If used in bureau drawers, in closets frequently opened, in pockets of clothing hung in closets, or in boxes which permit the fumes to escape, paradichlorobenzene is only partly effective and can not be depended upon for absolute protection.

Paradichlorobenzene should be used at the rate of about 1 pound to each 6 to 10 cubic feet of space. One pound of good flakes scattered between the folds of clothing in a trunk of average size should kill all stages of clothes moths. In tight chests of ordinary size the fumes given off by the slow evaporation of 1 pound of this substance will kill both young and well-grown larvae of clothes moths and prevent moth eggs from hatching. If a good grade of the material is used in tight containers there is no doubt as to the efficiency of its fumes. Too many persons expect moth flakes to be effective scattered about closet shelves or bureau drawers. It is not entirely so under such circumstances. If chests or trunks are not very tight much can be done toward making them so by sealing the cracks with adhesive paper or by papering them on the inside. If there is opportunity for the fumes to escape, use from 2 to 3 pounds of paradichlorobenzene to each 6 to 10 cubic feet of space.

Pyrethrum Powder.

Pyrethrum powder, if fresh, will kill clothes-moth larvae. Clothing should be thoroughly dusted with the powder and placed in a tight container such as a chest or trunk, or wrapped well in unbroken paper. Pyrethrum powder soon loses its protective value on exposure to air, hence is not considered particularly effective for long storage, and is inferior to paradichlorobenzene. It is not always easy to obtain fresh pyrethrum powder at stores.

Cold Storage.

The best method of protecting against injury by fabric pests of all kinds is cold storage. It is the best method because it eliminates all error on the part of the owner. Once in cold storage no injury can take place. Cold storage is depended upon for absolute protection by dealers in carpets, furs, and other valuable articles such as stuffed animal heads, blankets, carriage robes, curtains, and upholstered furniture. Cold-storage facilities have increased with public demand until today no city or large town is without storage equipment.

Articles will be protected from injury in storage at temperatures ranging from 40° to 42° F. A number of years ago a manager of a large storage warehouse company in Washington, D. C., conducted certain experiments at the instance of the Chief of the Bureau of Entomology, with the result that it was found that larvae of the webbing clothes moth and of the black carpet beetle can withstand for a long time a temperature of 18° F. It has been discovered that it is not so much the cold that kills. It is the sudden change from a cold to a warmer temperature and back to a cold temperature that most quickly results fatally. Thus it was learned that if articles infested with clothes moths were refrigerated at 18° F. for several days, then suddenly exposed for a short time to 50° F., and then returned to 18° F., and finally held permanently at about 40° F. all moth life in them would be killed.

If storage concerns aim at the destruction of clothes moths in articles intrusted to them, as well as the protection from injury of these articles during the period of storage, it is recommended that articles be exposed to two or three changes of temperature as noted above before they are placed permanently at 40° to 42° F. The maintenance of a temperature lower than 40° to 42° F. is needless expense.

If the storage company merely guarantees to protect articles during the period of storage, it is quite sufficient to maintain them at a temperature of about 40° to 42° F. Companies should advise patrons that clothes-moth larvae can withstand prolonged storage at temperatures ranging from 24° to 45° F. for longer periods than that for which the majority of articles are refrigerated. Thus well-grown larvae of the webbing clothes moth in fur and wool were held in commercial cold storage at a tempera-

ture said to fluctuate between 24° and 48° F., but held mostly at about 40° F., and have been found to be alive after storage for 6, 8, 10, 11, and 12 months. Larvae in fur helmets placed in storage during February, removed the following December, and held in a steam-heated building, transformed in considerable numbers into active adults by the middle of January. These adults showed no effects of the refrigeration of the larvae from which they had developed, but laid many eggs that hatched normally. Refrigeration for six months had no noticeable effect upon the larvae, except to hold them inactive and incapable of causing injury. While larvae refrigerated for 10 to 12 months matured, as above stated, into moths, a large percentage, though active soon after removal from storage, died after being subjected to warmer temperature. These facts are important, for they explain why patrons have at time found living active, and robust larvae in articles several days after removal from 4 to 5 months in cold storage. If a fairly even temperature has been maintained, such a discovery is to be expected. If articles are cleaned thoroughly before being placed in storage of any sort, as they always should be, the likelihood that they will contain well-grown larvae is very slight.

Fumigation.

Fumigation has certain advantages in that it can be applied to large rooms or an entire building with effective results. Although dangerous to human life, hydrocyanic-acid gas is effective, has no fire hazard and does no damage to the articles fumigated, so it is recommended by the U. S. Department of Agriculture for use by any person who understands the hazards and can take the necessary precautions.[1] Hydrocyanic-acid gas is readily ventilated from a building or room after fumigating.

An alternative method of fumigation is by sulphur fumes, but in addition to the fire hazard involved the bleaching and tarnishing effect of this method causes it not to be recommended. Contrary to a widespread belief, formaldehyde fumigation is worthless for killing clothes moths or other fabric pests.

Carbon Disulphide.

This is an unsafe substanse to use, in spite of the fact that the U. S. Department of Agriculture recommends it. No description of the other hazardous methods has been given in this digest; as safe methods are the subject; but the hazard of carbon disulphide warrants special comment. This substance is peculiarly dangerous because of its low ignition temperature and explosive properties, being more hazardous than gasoline or any of the other flammable liquids in general use.

[1]Complete information on the subject of fumigation with hydrocyanic-acid gas is given in Farmers' Bulletin No. 699, obtainable from the U. S. Department of Agriculture, Washington, D. C.

While the hazardous nature of carbon disulphide vapor is mentioned in the U. S. government bulletin it is not particularly emphasized except that persons are warned to keep it away from fire in any form. Its use for fumigation of entire buildings is warned against because of the fire hazard, which is apparently not considered just as serious when used locally. Its hazard in such local use is described as comparable to gasoline or benzine.

Because it is not effective at temperatures less than 65° F., it is recommended that the disulphide be used at temperatures above 70° F. This may be assumed to increase the volatility and increase the hazard. In view, however, of the availability of carbon tetrachloride, a perfectly safe substance, it is not at all necessary to expose life or property to the hazard of carbon disulphide.

Carbon Tetrachloride Fumigation.

Carbon tetrachloride is a good fumigant for single rooms, closets, trunks, chests, and other tight containers. It is a thin, transparent, colorless liquid, in appearance similar to water, that evaporates on exposure to air, forming a gas with a pungent, aromatic odor. Its gas is heavier than air. It has the great advantage over carbon disulphide that its gas is neither explosive nor flammable, hence there is no fire risk in its use. Carbon tetrachloride is purchased at drug stores or from chemical firms in cans containing 1 or more pounds of liquid, and costs from 10½ to 30 cents a pound, according to the quantity purchased. It should be used at the rate of 8 to 12 pounds, or more, per 1,000 cubic feet of space if containers are very tight. When the temperature is 70° F. or above, good results in killing clothes moths should follow if the quantities given below are used. Since the gas is heavier than air, the liquid should be exposed in shallow dishes at the top of the container to be fumigated.

QUANTITIES OF CARBON TETRACHLORIDE NEEDED FOR FUMIGATION.

Space to be fumigated.	Quantity needed.
Room, 12 by 10 by 8 feet	12 pounds or 4⅞ quarts.
Closet, 3 by 8 by 8 feet	2¼ quarts.
Closet, 2 by 5 by 7 feet	2½ cups.
Closet, 4 by 5 by 7 feet	4½ cups.
Trunk, 21 by 20 by 42 inches	½ cup.
Box, 1 by 2 by 2 feet	3 tablespoonfuls.

Cedar Chests.

Chests made of the heartwood of red cedar, such as are found on the market, not only are so tightly constructed that the moths can not enter them when closed, but the aroma of the wood kills the newly hatched or young larvae of the clothes moths. If in good condition as regards tightness, therefore, cedar chests are effective in protecting fabrics from clothes-moth attack when precautions are taken to beat, brush, and, if possible, sun the articles before they are placed in the chest.

The average trunk in which clothing is stored is not tight enough to keep out moths. Indeed, the unusual tightness of cedar chests, when not cracked or warped, compared with ordinary trunks or other ordinary household receptacles for clothing, gives to such chests a great advantage, in addition to their definite insecticidal value.

The value of cedar chests in protecting clothing lies in the fact that they kill the newly hatched or young larvae or worms of clothes moths. Cedar chests can not be depended upon to kill the moths or millers, their eggs, or the worms after they are one-half to full grown or after they are 3 or 4 months old. Neither will the chests kill all the pupae or chrysalids. It is because they will not kill these stages of the clothes moth that cedar chests are recommended as protectors of clothing from moth attack only when fabrics put into them are thoroughly cleaned, brushed or beaten just before they are placed in the chests. This preliminary treatment before storage, if carefully done, with special attention to brushing out pockets, seams, etc., will remove those stages of the moth that the chests will not kill.

Dry Heat.

Heat is now recognized as an effective agent in killing insects. All fabric pests will be killed in a very short time if rooms can be heated to a temperature of 130° F. long enough to permit all articles in the room to be thoroughly heated through to this temperature. Experimental work has demonstrated that even lower temperatures will kill the larvae of clothes moths. All larvae exposed in an incubator at 128°, 120°, and 110° F. died in 6, 11, and 31 minutes, respectively. At 105° F. 20 per cent were dead at the end of 31 minutes, while at 110° F. 30 per cent were dead at the end of 11 minutes. This killing power of heat can be readily utilized by ironing fabrics with very hot irons, or exposing them in superheated rooms before they are put away for the summer.

The rays of the sun in summer can often be used to kill or drive clothes moths from fabrics. Thus clothes-moth eggs on flannel, exposed to the bright sun at 128°, 125°, 120°, and 110° F., were killed at the end of 6, 6, 11 and 31 minutes, respectively. Exposure to the sun at 110° and 105° F. for 31 and 11 minutes, respectively, did not kill the eggs. Well grown larvae of clothes moths in garments exposed for several hours to the hottest rays of the sun usually become restless and spin down from the garment. The old-time custom of sunning clothing to kill moths is based upon excellent experience.

Hot Water.

Fabrics that will not be injured by water can be freed of living clothes-moth eggs and larvae by being dipped for 10 seconds in water heated to 140° F. Care, however, must be exercised to have and keep

the water at this, or a greater, temperature. Larvae and eggs in flannel dipped for 10 seconds in water heated only to 122° F. remained unaffected.

Laundry Soap.

Clothing washed with a strong solution of neutral laundry soap will be freed from clothes-moth larvae and eggs, and if wrapped tightly in paper, as suggested above, as soon as taken from the drying line, will remain free from moth attack.

Worthless Substances.

The following substances often recommended for clothes-moth control are worthless:

Tobacco extracts containing nicotine and tobacco powder when used at reasonable strengths.
Lavender flowers (scattered on).
Cayenne pepper.
Allspice (dusted).
Angelica root (dusted).
Black pepper.
Pyrethrum stems (dusted).
Lime, air-slaked (dusted).
Powdered sulphur (dusted).
Salt (dusted).
Quassia chips (dusted).
Borax (dusted).
Colocynth pulp (dusted).
Eucalyptus leaves (dusted).
Hellebore, white (dusted).
Formaldehyde (sprayed 1 to 10).
Sodium bicarbonate (dusted).
Sodium carbonate (dusted).
Lead carbonate (dusted).
Lead oxide (dusted).
Red cedar leaves (dried and placed in clothing).

Cedar chips and cedar shavings, while useful if they are at full strength, lose their characteristic odor rapidly as they dry and are considered impractical.

An Obstructed Sprinkler Equipment.

By E. T. Holman, Chief Inspector.
Tennessee Inspection Bureau (Member N.F.P.A.).

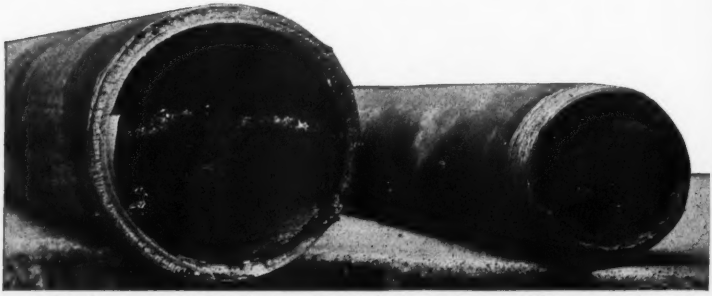
On Sunday afternoon, November 19, 1923, a terminal grain elevator of the Hermitage Elevator and Warehouse Company at Nashville, Tennessee, burned to the ground with a loss of some $400,000. Although equipped with automatic sprinklers, these failed to work and the investigation of the fire failed to shed any light on the reason why. The elevator in question was beyond the limits of municipal protection, but the fire was fought by the Nashville Fire Department.

This plant was a railway terminal elevator, of frame, iron-clad, ordinary joisted construction, of six to ten stories in height, and of about 27,000 square feet in floor area. The elevator had a storage capacity of one-half million bushels of grain and used the processes commonly found in this occupancy, that is, grain drying and cleaning, oat clipping, etc., and was equipped with such machinery as necessary for this process.

The building was erected in 1906; upon completion was equipped with what was then regarded as a standard automatic sprinkler equipment, supplemented by private outside protection from fire hydrants and hose.

Being situated beyond the limit of city water mains, a private water supply was necessary. To meet this requirement a pumping station was erected on the bank of the Cumberland River, one mile distant. Two non-automatic, compound, duplex pumps of 1000 G.P.M. each were installed, taking suction directly from the river, and discharging through one mile of 10-inch main to the plant.

Located fifteen feet above the roof of the elevator were two wooden gravity tanks of 15,000 gallons capacity each, which constituted the primary source of water supply for the sprinklers and the outside protection,



Random cuts through 3 and 1½ inch mains showing mud deposits. This obstruction, found in the sprinkler piping of a warehouse of the same plant which did not burn, suggests a reason for the failure of sprinkler piping in the fire which destroyed the Hermitage terminal grain elevator at Nashville, Tennessee, November 19, 1923.

and into which was pumped the raw and frequently very muddy river water.

Following the fire a reason was sought that would explain the failure of the automatic sprinkler equipment to make at least a showing, which, according to the testimony of those in a position to know, it did not do. That there was water in the elevated tanks is sufficiently evident; for the outside hydrants were used immediately, although without effect as only a feeble stream was obtainable. The pumps at the river were not brought into use for a long while after the fire started.

Very little of the building remained for examination, but it was discovered that at least one of the dry-pipe valves could not have been in an operative condition before the fire. This was only one of five valves located in the elevator, the other four being covered to such a depth by debris that they could not be reached for months. It is fair to assume, however, that they were not in a similar condition.

This fire added to the list of sprinklered failures another for which there seemed to be no plausible explanation. Recent events, however, have pointed the way to a solution of the mystery.

A portion of this plant consisting of a sprinklered warehouse, detached several hundred feet from the elevator, did not burn and remained vacant until recently, when it was purchased and occupied by a broom manufacturer who wished to place the unused sprinkler equipment in commission again. It was then that a possible solution of the puzzle presented itself.

As the city main had by that time been extended to within a few feet of the building, it was supposed that very little additional equipment would be required to put the sprinkler system in order other than a yard main connecting the two dry valves with the city supply. However, it became necessary to cut one of the cross mains for the purpose of installing some

Above, three and one-half inch flange and screw elbow almost blocked by sediment. Below, valve springs and gasket found lodged in pipe lines of sprinkler system.

heads, and a pipe, supposed to be devoid of any matter more tangible than air was found so thoroughly clogged with earth that nearly two-thirds of its effective capacity was lost. A condition so unexpected and unusual demanded immediate investigation. A close examination revealed the startling fact that all the smaller pipes were entirely filled with sediment, and would have failed utterly to function, had not chance revealed their worthless condition. Apparently a similar condition prevailed in the sprinkler system which failed in the fire three years ago.

The one source of supply was the Cumberland River; all flowing streams may carry at one time or another sufficient sediment in their waters to block absolutely, not only the smaller lines, but also the larger cross mains, as the accompanying pictures demonstrate. These pictures are reproductions of the condition of the pipes when removed from the factory system and disassembled. In view of their condition, we are forced to the conclusion that this provides the most plausible reason as to why the

sprinklers failed to function at the time of the fire in 1923.

While it is true that the raw water produced the sediment that was largely responsible for the sprinkler failure, still there was, at that time, a practice in automatic sprinkler protection, of intermittently turning dry pipe systems wet, thus encouraging a settling of sediment in the pipes. This practice is no longer regarded with favor. Another deficiency in those days was that dry pipe systems were not equipped for inspector's tests, by means of which it may be ascertained if water is flowing through the system.

There are doubtless other sprinkler systems throughout the country similarly supplied with water from an occasionally muddy source. The experience in this case may prevent other failures from this cause in the future.

F. M. Follett, in the *Saturday Evening Post.*

"Don't do that, George! You might start a forest fire!"
"Quit yer kiddin'! The fastest forest fire in the world couldn't catch this car!"

Jewelry Manufacturing Hazards.

By Albert F. Brown.
(Member N.F.P.A.)

Jewelry, as an adornment, is worn by nearly all peoples of the earth; by the savage in the jungle, and the people of the most highly civilized nations. The beauty and design varies with the development of the races, from the crude beaten out pieces of metal to the beautiful and highly artistic designs.

In these modern times there are various grades of jewelry, from the high grade solid gold and platinum to the cheap imitation and plated material. In general, the high grade article is made in the better buildings, and the cheap grades are frequently made in tenant buildings. The processes in making cheap jewelry are somewhat more hazardous than those of the better grades.

According to the census of 1921 there were in the United States 1671 jewelry establishments, employing 23,482 wage earners, and with an annual production valued at $127,230,777. In 1923 the number of establishments had dropped to 1622 but the number of employees had increased to 26,354 and the value of the product to $174,034,000.

Raw Stock.

The materials used by jewelers are gold, silver, platinum, brass, zinc, tin, precious stones such as diamonds, rubies, emeralds, pearls, sapphires, and imitation stones.

The proportion of pure gold contained in any alloy of gold with other metals is designated by karats, 24 karats as designating pure gold; thus an 18-karat gold contains 18 parts of gold and 6 parts alloy. A good 14-karat gold contains 14 parts of fine gold, 3 parts of silver and 7 parts of copper.

Sterling silver contains about 92% of silver and 8% of copper. Less silver and more copper makes a hard alloy but it is not sterling.

Processes and Hazards.

Whereas the ancients wrought by hammering, chasing and repoussé, the present day jeweler depends very much upon the processes of melting, casting, drawing or rolling, stamping, soldering, plating, oxidizing, lacquering, enameling and buffing. These processes will be described in the order given.

Melting gold or silver with an alloy is a simple process and is usually done with a comparatively small amount of the material. In alloying silver, copper is extensively used, but it oxidizes readily and some manu-

facturers are using zinc, bismuth, nickel and cadmium. The melting furnace is a small cast iron pot with a fire clay lining through which there are several holes for the flame to pass to the crucible. The crucible is known as a black lead crucible. The operation is to place the alloy first in the crucible and to heat this to the melting point; then to add the precious metal, the contents of the crucible being constantly stirred. Illuminating gas furnishes the heat, a blast flame being produced with compressed air. The melting furnace is usually on iron legs, a good distance above the floor and the gas and air piping is iron and permanently fastened to the furnace. The fire hazard is light but there may be an explosion if the furnace is allowed to fill with gas before the gas is lighted. Some manufacturers melt copper in considerable amounts for gold plating and rolling. In this case the more intense heat is necessary than that obtained from gas, and fuel oil is used. The method is to pump the oil to the burners from an outside buried tank. Platinum melting requires a very high heat and in this case a oxy-hydrogen gas flame is used. The hazard in this process is largely in the gases used. The oxygen is a supporter of combustion and the hydrogen gas is very flammable. These gases are in steel cylinders and under heavy pressure.

They require careful handling in transportation. A few manufacturers use a high frequency electric furnace for melting.

Casting is pouring the melted metal into sand or other moulds and thereby obtaining a cast product of the piece of jewelry desired, or an ingot of the metal which is then rolled to a desired thickness for the work in hand. In casting small work such as rings and ornaments, and where a metal pattern is available, a mould made of cuttlefish bone is generally used. There is practically no hazard in this process except, possibly, by careless pouring, the hot metal may drop on combustible material.

Rolling the cast ingot is to pass it through two rolls, repeating the process until the desired thickness is obtained. In this process either a flat piece of metal or a fine wire can be obtained, depending on the type of rolls used. In some small shops the wire is reduced to any desired size by hand drawing. There is no hazard in this process, except that as the metal is being reduced in size, it becomes hard or brittle, and must be annealed a number of times during the process in order to soften it. This requires heating in an annealing furnace. Generally these furnaces are small, heated by gas with air mixture, and are well arranged.

Stamping is a simple process but requires considerable skill in the operator of the press. A hardened steel die, upon which there has been cut or imprinted a negative form of the object to be stamped, is placed upon a heavy press which has a drop hammer raised either by foot power or by electric power.

When thin gold or thin silver is stamped there is danger of "star cracking" the metal unless it is first oiled, and in some shops a mixture of one part gasoline and two parts light machine oil is used for this purpose. In other shops, carbon tetrachloride is used. The metal is dipped in the liquid and then placed in the stamping machines.

The hazard from the gasoline solution is slight as generally only a day's supply is kept in the shop, the main supply being mixed and stored in a safe location. There is of course no hazard from the carbon tetrachloride.

In some classes of work the stamped article is taken to a press where it is pierced and trimmed or bent over on the edges.

A hazard, not directly due to the stamping process, but, nevertheless, chargeable to stamping, is in the care necessary to keep the dies in good condition. Unless the dies are to be used again within a few days they are protected from rusting by a coating of oil or vaseline, and this must be removed before the dies are used again. To remove this oily protection the dies are cleaned in naphtha or gasoline. The danger from fire in the use of a flammable solvent is slight on account of the care and small amount used.

There is one small fire from the use of gasoline in cleaning dies on record and this was due to the carelessness of a boy in burning the waste.

Soldering or brazing to be done successfully requires the removal of all oil or grease by washing in a heated alkali solution such as potash or sal soda, dissolved in water. After soldering, the scale, tarnish or other stains are removed by immersion in a hot pickle of one part sulphuric acid and three to nine parts of water. It is of course necessary to pour the acid into the water as the mixture generates heat so rapidly that if the water is poured into the acid it would spatter violently, which might blind the worker. Soldering is done by gas flame, on long wooden benches, built along the sides of the room so as to get the most light available. Generally the benches are unprotected, and some are found charred by the gas flame. Other benches are protected by a metal or asbestos plate. Along the back of the benches are two supply pipes, one for gas, and the other for air. Each worker has a blowpipe connection to these two pipes and when the blowpipe is not in use it is hung on a hook which in some cases automatically shuts off the air and reduces the gas flame to a small pilot light.

The hazard in soldering consists in the use of gas flame, intensified by the mixture of air. This hazard is greatly reduced by the careful use of the blowpipe by the worker. Every night, and in some shops at noon, the gas is shut off at the meter, and this eliminates the danger from fire

after the worker has left the bench. The real reason for doing this is not on account of fear of fire but on account of a possibility of explosion. It has been found that if the air supply is shut off, and the gas is allowed to burn, the air pipe is liable to fill with gas, and when the air is again turned on an explosion in the air pipe is likely to occur. This has occurred in some plants and although fire did not follow, the air pipe had to be replaced.

Plating is applied to the cheaper grades of gold or silver jewelry, and such plated pieces constitute the bulk of jewelry made. The best plating is rolled or stock plate and is made by soldering the gold to the base metal in the ingot which is then rolled into sheets or wire. The thickness of the gold on the ingot is gauged so that after the ingot has been rolled to the required thickness there is a thin layer of gold over the whole surface of the base metal. This method gives a better plating than the electroplating method.

Electroplating is the process of depositing gold or silver on a base metal by the means of an electric current. This current is generated in the shop by a small direct current generator and does not exceed 15 volts.

Gold cannot be dissolved by common acids when taken singly, but the metal is completely soluble in *aqua regia,* a mixture of hydrochloric (muriatic acid) and nitric acid.

Gold chloride is made by dissolving gold in *aqua regia* and evaporating until the residue is almost a syrup. To this is added distilled water and further evaporated, after which liquid ammonia is added until all the gold is precipitated in a spongy mass in the bottom of the bowl. Particular care has to be taken not to add more ammonia than is necessary because when the gold is precipitated it becomes an unstable compound called "fulminating" gold, which, if it dries or is gently heated, becomes explosive.

The electroplating apparatus consists of one or more troughs or crockery bowls set in water heated by steam pipes. Across the bowls are two copper rods, connected respectively to the positive and negative poles of a generator. The objects to be gilded are suspended in the "gold" solution consisting of gold chloride and potassium cyanide. They are attached to the negative pole of the generator and a sheet of copper is attached to the positive pole. After the current is turned on, the gold in the bath is deposited on the objects attached to the negative pole which remain in the bath a definite time, depending on the desired thickness of the deposit. In order to keep the bath solution in a state of concentration, a piece of gold is suspended from the positive pole which dissolves at the same rate that the gold in the bath is deposited on the objects attached to the negative pole.

In electrosilvering the process is substantially the same as electrogilding just described.

In both of these processes the fire hazard is light. The acids used cause corrosion and sprinklers and piping must be protected against this.

Oxidizing gives a darkened surface to polished silver. This is done by simply brushing the silver with a liquid compound of sulphur and toning down with a buffing wheel or rubbing with soda and pumice stone. The compounds of sulphur generally used are potassium, sulphide ammonium sulphide and barium sulphide. Sulphide of ammonia is mostly used, and is known in the shops as "liver of sulphur." These sulphides in dry form are subject to spontaneous ignition.

Lacquering consists of coating a base metal with a varnish to give it a gloss and to prevent tarnishing. A cheap lacquer consists of virgin rosin dissolved in fusel oil and thinned with gasoline. A "cotton lacquer" (pyroxylin lacquer) is composed of a solution of gun cotton and amyl acetate. Some lacquers are made by dissolving scrap transparent pyroxylin in amyl acetate. Lacquer in jewelry factories is generally kept in a covered crockery jar, and the articles to be lacquered are dipped by hand in the liquid or, in some cases, they are sprayed by forcing the lacquer by air pressure through a spray nozzle. This latter method is done in a spray booth which should be arranged and vented in a standard manner.

Occasionally the lacquered articles are allowed to dry in the open room but usually they are dried in a steam heated metal or wooden closet, the steam pipes being located near the bottom of the closet.

The hazard in this process consists in the highly volatile and flammable solvents used. No open flame should be allowed in a lacquer room. The electric lights should be protected by vapor-proof globes, and smoking should never be permitted.

Enameling is a simple process, yet requires an expert on the better grades of work. Enamel is glass combined with different metallic oxides to give the desired color, and can be purchased in the colors needed.

There are three kinds of enamel—transparent, translucent, and opaque. Transparent enamel reflects the color and surface of the metal, translucent admits the light but partially, and opaque gives color on the surface only.

Before enamel can be used it must be ground into a fine powder. The better grades of enamel are ground by hand with a granite mortar and pestle. Some factories break the enamel into comparatively fine powder by placing it in an iron cup and then repeatedly dropping a heavy metal weight upon it, after which it is placed in an earthen jar containing small stones, and this jar is then strapped to a machine and allowed to revolve until the desired fineness is obtained.

To apply the enamel to a piece of jewelry it is first mixed with water to the consistency of a paste and spread on the metal with a fine brush. It is then set in a warm place until the enamel is entirely free from moisture, after which it is fired in a gas-heated or an electric-heated oven having a temperature of 1400 to 1600 degrees Fahrenheit. This firing process simply fuses the powdered enamel into glass again. This is sometimes repeated three to four times according to the number of colors in the piece. Before the last firing it is smoothed off with emery stone, and washed with hydrochloric acid.

The hazard in this process is confined to the type of furnace used. The gas heated furnace is more hazardous than the electric furnace, but in either case the number of fires reported is small as the furnaces are generally well arranged.

Buffing is generally the last process in the manufacture of jewelry which gives the article the desired polish. The buffing wheel is made up of a large number of cotton disks securely fastened together. Before the buffing wheel is used a stick of "crocus" is held against the wheel during a few turns of the wheel. This "crocus" is composed of linseed oil and a powdered mineral.

The hazard in this process is in the cotton lint from the buffing wheel mixed with the "crocus" polish, which is subject to spontaneous ignition, especially when confined in a receptacle. A blower system and conveyor pipes carry the dust to a tank and these should be kept clean. On account of the value of the metal which is buffed off the dust is generally saved and refined.

It is customary to blow the dust into a covered tank of water and this, if properly arranged, should be safe. In some shops the dust is blown to a cyclone dust collector which is connected at the bottom to a dry metal can. In this case the necessity of separating the water from the dust is eliminated.

Acids.

Considerable quantities of sulphuric and nitric acids are used and in the larger plants these are received in carboys. The hazards of these strong acids are well known. In addition to the hazard of mixing with water already described, care should also be taken not to drop strong acid on combustible material, like straw, as the chemical reaction may result in fire.

In jewelry shops nitric acid is used as a pickle to clean jewelry. The work is generally done under wooden hoods, vented to the outside and above the roof of the building through wooden vent pipes. Fires have started in these wooden vent pipes due to the condition of the wood after being nitrated by the acid.

Cleaning Liquids.

During the manufacture of jewelry, it is necessary to occasionally clean the metal from oil or grease, and in most shops this is attended with no fire hazard. A few shops use gasoline for cleaning, the hazard of which is well known.

Generally, oil or grease is removed from the metal by washing in an alkali solution such as potash or sal soda dissolved in water, and used hot. A few drops of ammonia is sometimes added to the solution.

Cement.

A cement is used in some stone and ornament settings. The nature of the cement depends upon the work in hand. The ordinary cement consists of a hard composition of the nature of sealing wax which is heated by a flame and when cooled will resist considerable pressure. A gum mastic thinned in alcohol is also used.

Imitation pearls are cemented by a patent solution or by ordinary liquid glue. A specially prepared cement is used for pearls, and for large pearls a white shellac is said to be excellent. It is purchased in lump form and used by heating over a small alcohol lamp.

The hazard in cementing consists in the use of a portable gas or alcohol lamp which is liable to be tipped over and come in contact with flammable material. These lamps should be heavily weighted on the bottom, or fastened permanently to the work bench.

Pyroxylin Plastic.

Some shops use a comparatively small amount of pyroxylin plastic on the jewelry manufactured, and others use a large amount in the manufacture of pyroxylin jewelry, ornaments and novelties, and may well be called pyroxylin jewelry manufacture.

Where a small amount of pyroxylin is used it is generally in very thin sheets, and may be used for backing, such as for collar buttons. In this case the process is to simply stamp out the pyroxylin and form it around the metal part.

There is little hazard to this process. The actual hazard is in the storage of the sheet pyroxylin and the waste material.

The main supply of pyroxylin should be stored in a ventilated detached fire-resistive building, and where less than 250 pounds is the main supply, it may be stored inside the building but should be kept in a metal-lined box or all metal drawer. Pyroxylin scrap should be kept in an all metal covered can and should be frequently disposed of.

Packing Room.

The hazard in the packing room is in the excelsior and waste paper used for packing, and the sealing of packages by a wax which is melted by a gas flame.

The excelsior and waste paper should be kept in a covered metal-lined box, or in an all metal covered receptacle. The gas flame for melting wax should be a permanent fixture, and away from combustible material. Smoking should be strictly prohibited.

Suggestions for Construction.

Jewelry factories should be preferably of standard mill or fire-resistive construction with the power plants in a detached or cut-off section. The work is such that cut-offs are not necessary for any of the processes except the lacquering which should be in a good shut-off room, well ventilated to the outside air.

Where valuable metals are used it is desirable to keep the main supply in vaults. It is important that these vaults be of standard construction, and designed to protect their contents even should the building be totally destroyed. To this end all inside partitions and shelves should be metal.

Suggestions for Fire Protection.

The hazards of jewelry factories are such that there is nothing in the fire protection that requires special attention. The 2½ gal. soda acid extinguisher is suitable for this occupancy, and the foam type extinguisher is not needed unless there is an unusual amount of lacquer present. Automatic sprinklers, installed in accordance with the standard rules, are desirable. Wax coated or non-corrosive sprinklers should be used in plating rooms, and in other locations where there are corrosive fumes.

Fire Record.

The N.F.P.A. Department of Fire Record shows 302 fires in jewelry factories. Of these 108 were due to special and 110 to common hazards. There were also 74 of unknown origin, 9 incendiary and one from exposure.

The following table gives the special and common hazard causes:

SPECIAL HAZARDS.

Forges	17
Buffing and blower systems	16
Lacquering	9
Gasoline	8
Pyroxylin Plastic	7
Refining furnaces	5
Drying	5
Nitric acid	3
Melting	3
Pitch and rosin	3

SPECIAL HAZARDS, Continued.

Enameling	2
Sulphuric acid	2
Soldering	2
Tempering	2
Japanning	2
Miscellaneous	22
	108

COMMON HAZARDS.

Smoking	38
Oily material and sweepings	32
Electrical	12
Heating	9
Boiler and chimney	5
Motors	4
Chimney sparks	2
Lighting	2
Fuel	2
Coal	2
Clothes closet	1
Ventilating fan	1
	110

Of the above 10% were small no claim fires.

Bush Fires in Australia.

During the last summer season in Australia, the State of Victoria was visited by a series of disastrous "bush" or forest fires. Loss of life is not common in forest fires so the great number of casualties which were caused made these fires noteworthy.

During the first two weeks of February, 1926, a number of bush fires were burning under greater or less control throughout Victoria. On Sunday, February 14, an epidemic of bush fires seemed to break out all at once all over the southern part of Victoria. The most disastrous of the fires and those largest in extent were on the slopes of the great dividing range which is made up of foothills of the Australian Alps. These fires raged with uncontrollable fury all day Sunday and part of the following day and were not entirely under control until two or three days later. When most of the smoke had cleared away and stock could be taken, it was found that there were 31 known dead and probably a half dozen others missing.

Through the courtesy of the Fire Underwriters Association of Victoria (Member N.F.P.A.) the QUARTERLY was able to secure some details of the fires.

Map of Victoria showing the areas affected by the disastrous bush fires of the middle of February, 1926, which cost some 31 lives.

Left, making a stand against the fire at a firebreak in the district where greatest loss of life occurred. Right, the dense vegetation of the fern gullies which, dried by the extended period of hot weather, contributed markedly to the spread of the fires.

Apparently there had been several days of exceptionally warm and dry weather and the forest land had become abnormally dry. It is, therefore, small wonder that the fires spread as they did with amazing rapidity. Eye witnesses asserted that the fires often traveled as fast as 20 miles an hour through the dense brush and woodlands. Flames rose at times 200 feet in the air, striking panic into the hearts of the inhabitants of the wooded districts, as they roared along.

The most serious fires occurred in the timber country east of Melbourne in the hills. One town, Noojee, was completely wiped out and several others lost valuable properties. Scarcely any of the towns in this section escaped some damage as the fires burnt through all the woodland around most of them. It was in this section that the principal loss of life occurred. The loss of life can be directly traced to the rapidity with which the fire traveled, oftentimes completely surrounding and trapping isolated dwellings and settlements. Many of the people who came through the fire safely were able to save their lives only by being near some stream in which they could find shelter with wet bags or cloths over their heads until the fire had passed. The fires created a reign of terror in certain districts. At Noojee was a power station which supplied the electric light for a considerable part of the surrounding territory. Early the fire cut off this power and the surrounding country was plunged into darkness. The destruction by fire of a wooden trestle railroad bridge on the main

The smoldering ruins of the town of Noojee which was completely wiped out by the disastrous bush fires. The upper picture was taken through the smoke haze from a hill overlooking the town. Below, another view, showing all that was left of the post office and a store.

line to Noojee cut off aid to that town. Even where there was no fire the countryside was covered with a pall of smoke so dense that automobile head lights were necessary in traversing roads at 3:00 o'clock in the afternoon.

This was a timber district and many valuable lumber mills have been destroyed. With the destruction of these mills and also the forest which provided their lumber supply, this district is greatly impoverished and necessarily its inhabitants will have to look elsewhere for employment.

An interesting feature of the fires is the fact that they started practically simultaneously in so many different sections of the state and sometimes many miles apart. While no doubt some of the fires were caused by

embers from the larger fires, probably the atmospheric conditions caused by the long period of hot dry weather had the most to do with the starting of the fires. One of the things which contributed to the spread of the fires was the numerous beautiful fern gullies which are densely packed with vegetation and which must have been highly flammable at the time.

Some of the fires are believed to have been set and a police investigation was started. But the combination of the fact that there were more people in the forest during the week-end, the fires already smoldering and the hot spell, explains most of them.

Extinguishing Carbon Bisulphide Fires.

Carbon bisulphide is probably the most hazardous liquid used in manufacturing processes today. It can be ignited when at temperatures as low as 20 degrees below zero, and when heated to only 300 degrees it ignites of itself. A fire once started is very difficult to control, the ordinary methods of extinguishing being practically worthless, and the choking fumes of sulphur dioxide given off making approach difficult unless there is ample ventilation. Furthermore, the vapors of carbon bisulphide are explosive, so that an additional serious hazard is present when this liquid is used in a confined space.

The use of this material has not been extensive. It is an important raw material in the new viscose rayon industry, and is used somewhat in the rubber industry. On a small scale one finds it occasionally in connection with special processes in other plants.

Tests to determine the value of various extinguishing agents on fires in this material were made recently at the Everett Testing Station, which is maintained by the Factory Mutual Laboratories. Practical conditions were approximated by igniting carbon bisulphide in open tanks, and attempts were made to put out the fires with various extinguishing agents. These tests showed conclusively the extreme hazard and the difficulty of extinguishing fires in the liquid.

Sawdust and soda mixture, a good extinguisher for fires in most hazardous liquids, was found to be ineffective until enough of the material had been added to absorb all the liquid. Even then vapors continued to pass through a blanket of sawdust and burn at the surface.

Carbon tetrachloride did not extinguish the fire even after a quantity equal to the amount of carbon bisulphide had been added. In view of the large amount of carbon tetrachloride which would be required, it is not

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considered a suitable extinguishing agent, except in enclosed spaces, where the inert atmosphere produced can be maintained.

Foam had little cooling effect, and although it greatly reduced the severity of the fire for a time, it could not be depended upon as a positive extinguishing agent, because vapors of carbon bisulphide penetrated the foam blanket and continued to burn at the surface and along the edges.

Water from automatic sprinklers or from hose streams is ineffective because of the splashing which takes place. This increases the intensity of the fire and may force the burning liquid over the sides of the tank and so spread it over a large area.

The most effective method was found to be by the use of water allowed to flow quietly into the burning material from a low pressure hose stream, or admitted to the liquid at moderately low pressures through a perforated pipe below the surface. The important thing is to apply the water, which is lighter than carbon bisulphide and does not mix with it, so that no splashing occurs. The water collects on the surface and extinguishes by a blanketing rather than a cooling action, although the cooling action is probably sufficient to lower the temperature of the burning bisulphide below its boiling point.

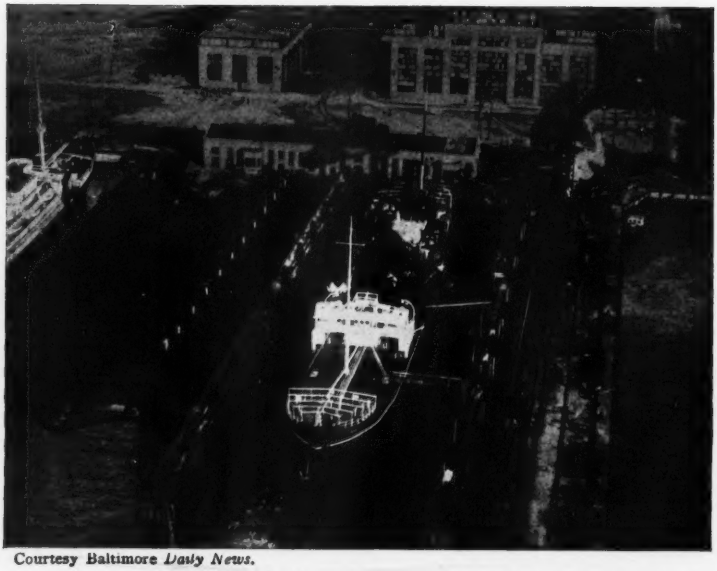
It is apparent that carbon bisulphide should be used inside main buildings only when absolutely necessary, and then only in small quantities. Processes involving its use should be located in outside detached buildings. Open tanks of the liquid should be equipped with perforated pipes at the bottom, with feed pipes of a diameter small enough so that the water will be delivered at low pressure and will not break the surface of the liquid. The controlling valve should be located in an easily accessible location some distance from the tank. Such an arrangement provides the quickest, easiest and surest method of extinguishing fires in open tanks of carbon bisulphide.

The S. S. Mantilla Explosion.

An explosion on the oil tanker *Mantilla* while in dry dock just outside the city limits of Baltimore on Friday, November 19, wrecked the vessel and is reported to have killed 18 and injured some 70 men. This explosion and the ensuing fire is of particular interest following as it does several similar disasters reported during the past year. These were described in some detail in the article by Mr. A. J. Smith, Secretary, N.F.P.A. Marine Committee, in the October, 1926, QUARTERLY, page 137. As in the case of similar disasters in the past, it appears that the trouble may be chargeable to failure to put empty oil tanks in proper condition prior to making repairs as prescribed in the N.F.P.A. Regulations on Marine Fire Hazards. In the absence of an official report, however, no definite statement can be made on this point. The following report, together with the accompanying photographs, has been furnished through the courtesy of the *Baltimore Underwriter*.

The explosion occurred on the Norwegian S. S. *Mantilla* at the plant of the Bethlehem Shipbuilding Corporation, Sparrows Point, Md., a short distance outside of the corporate limits of Baltimore. This ship, a tanker, had discharged a cargo of crude oil at the Mexican Petroleum Corporation, Curtis Bay, Baltimore, on the day previous to the explosion. The ship had been hauled out on drydock at the Bethlehem Shipbuilding Corporation plant, and was being gone over by workmen of the shipbuilding company and members of the crew of the steamship during the morning.

About 11 A. M., November 19, an explosion occurred, without any cry of "fire" or other warning, followed by several other rumblings or explosions, involving eight of the sixteen oil tanks of the ship, the explosions being followed by an outburst of flame. The eight tanks involved were amid-ships. The force of the explosion was terrific, blowing out the sides of the vessel, tearing the deck into shreds of twisted iron, and hurling winches and other huge pieces of metal for several hundred feet. Bolt heads shot through the air like rifle bullets. Hatch tops were thrown to nearby piers, as was a mass of burning oil. One huge piece of metal, weighing more than twenty tons, was thrown to a neighboring dock, a distance of more than 200 feet. Nearby buildings were denuded of wire glass and frames; portions of some roofs were carried away. Billows of flame shot through the dock, incinerating men as they ran. Portions of human bodies were hurled in every direction. Nine dead were accounted for later, and another nine were reported missing. Whether

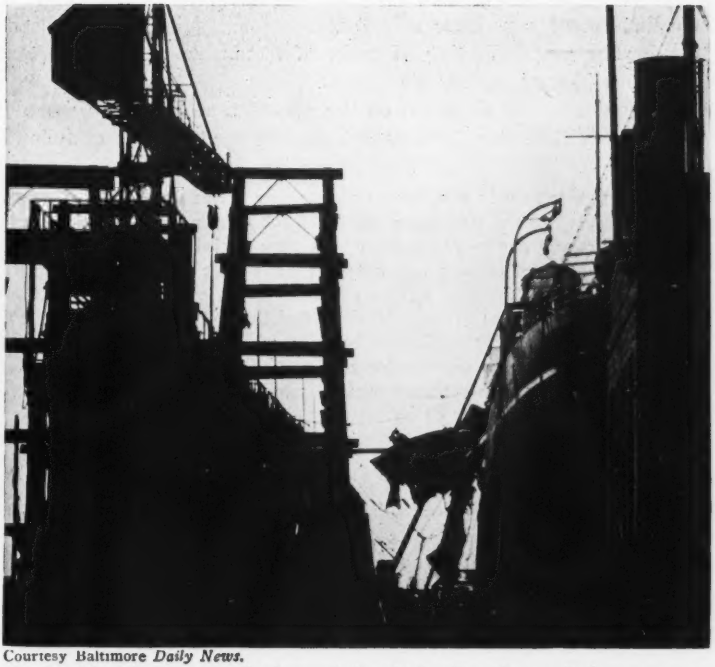


Courtesy Baltimore *Daily News*.

The S.S. "Mantilla" after the explosion and fire of November 19. At the left of this picture will be seen a mass of twisted iron formerly a part of the deck of the "Mantilla" thrown several hundred feet into a neighboring dry dock. One piece weighed more than 20 tons. Hundreds of wired glass windows in the buildings shown in the background of the picture were carried away by the barrage of bolt heads and other wreckage thrown by the explosion.

they were blown to pieces, hurled into the waters nearby, or whether these men merely disappeared after the accident, it is hard to decide.

While eight tanks of the ship let go, eight others were not involved, and the shipbuilding forces feared that they, too, would blow up. A call for help was sent to the Baltimore Fire Department and the Fireboat *Torrent* and a foam pumper were sent to the scene in charge of Deputy Chief Shipley. Chief Emrich later went personally to the scene of the accident to take charge. The fireboat crew used a foam stream made by pouring cans of foam producing powder into a continuous foam generator connected with an ordinary hose line. The foam pumper used the regular two solutions for this class of foam, using about 1,000 gallons of its supply, which gave a foam spread of probably 8,000 gallons. Possibly 20,000 gallons of foam spread from the continuous foam generator was also used. The use of these foams put out the fire in remarkable fashion, the shipyard officials being free to state that the ship would probably have been a complete loss had it not been for the work of the Baltimore firemen with foam. The firemen went up against a sea of flame in the center of



Courtesy Baltimore *Daily News.*

Looking into the cofferdam of the dock after the explosion gave an inadequate view of the manner in which the ship's sides were blown out. The overhanging mass of iron is a part of the port side that was not blown, with other pieces, for hundreds of feet. Not only were men working on the deck literally blown to pieces, but men working in the dock on the side of the ship were burned to death by the roll of flame that for a few minutes covered the entire length of the floating dock.

the vessel, taking the chance that another great explosion would wipe them all out. It was a splendid demonstration of the efficiency of both the fire-fighting force and the foam equipment.

The official report of the case of the Standard Oil tanker, *O. T. Waring* described in the article by A. J. Smith referred to above, was that no chemist had boarded the ship to test tanks for gas content prior to the explosion. No announcement has been made as yet in the Baltimore case as to whether the tanks were tested for gas content. After the explosion a chemist made tests of the eight remaining tanks for gas content before repair work was resumed on the vessel. The best accepted practice for removal of the gas content explosion hazard is to first vaporize the tanks with live steam and then thoroughly ventilate them.[1] It would seem

[1]For complete details of the recommended safe procedure for freeing oil tanks of flammable vapors, see Regulations for Marine Fire Hazards, Appendix A.

likely that recent experience may later force a requirement in all shipyards for the proper freeing of tanks of flammable vapors before any repair work is done on any oil tankers.

The cause of the explosion on the *Mantilla,* at Baltimore, is so far rather indefinite. It may have come from any one of the three following causes:

1. The attempt to light a cigarette or cigar near one of the tank hatches which were being painted at the time by members of the crew and in which the sight-holes may have been open. The hatch covers were hurled a considerable distance from the ship by the explosion and the sight ports were open when the hatches were found. The thread on the holes was not damaged, as would apparently have been the case had the force of the explosion lifted the sections free from the hatch covers, according to shipyard officers. Shipyard officials believe that these sight-holes had been left open by the crew during the painting operation.
2. Fume contact with either of two electric welders being used by the shipyard forces, one of them for repair of an ice chest on deck.
3. Fume contact with flame as the result of repair work on rivets on starboard side of ship where, the ship's officer says, acetylene torches were being used. The rivet testing crew had completed the port side of the ship, it is stated, and were working on the other side when the explosion came.

On this latter theory of the origin of the explosion, a member of the crew, Lars Larssen, when interviewed at the Marine Hospital, had this to say: "I was standing on starboard side of floating drydock and looking down at two men operating acetylene burners and two caulkers when I heard an explosion which sounded like a cannon, and then a ball of flame. I ran up deck to shore and when a piece of iron hit me on the left leg I fell. Men then came from shore end of dock and took me to land."

The report of Battalion Chief Edgar B. McKnew, head of the Fire Prevention Bureau of the Baltimore Fire Department, gives his personal opinion of the cause of the fire, which is of interest. This report is as follows: "In company with Capt. W. H. Jones, I inspected the S. S. *Mantilla,* Bethlehem Shipbuilding Corporation, Sparrows Point, and find that explosion had occurred in the cargo fuel oil tanks at center of ship. The force of the explosion opened deck and starboard side a distance of at least 125 feet, raising deck and pushing out starboard side. The force of explosion was so terrific that it actually tore 5/8-inch steel sheets. The explosion caused oil to be thrown around on dock, port side and over deck of ship, also scorching paint on lifeboat and woodwork on deck. At center of port side, at two places, rivet holes showed which had been burned out by acetylene torches. In my opinion the burning out of rivets built up an explosive gas in cargo hold and reached the right temperature, which caused explosion on ship."

The Hazard of Gas Holders.

The failure of a gas holder at Evansville, Indiana, in June, 1926, directed attention to the potential fire and life hazards of the large number of gas holders in cities the world over. Some N.F.P.A. members, with the remembrance of a spectacular gas holder fire in Chicago in 1922, have felt that there is a considerable hazard in the storage of huge quantities of so flammable a commodity as illuminating gas. From the fact that the gas holders involved at Chicago and Evansville were both quite old it has been argued that as other holders increase in age the danger of failure due to deterioration will materially increase. Following is a study of fires in gas holders reported to the N.F.P.A. Department of Fire Record from which the hazard may be estimated.

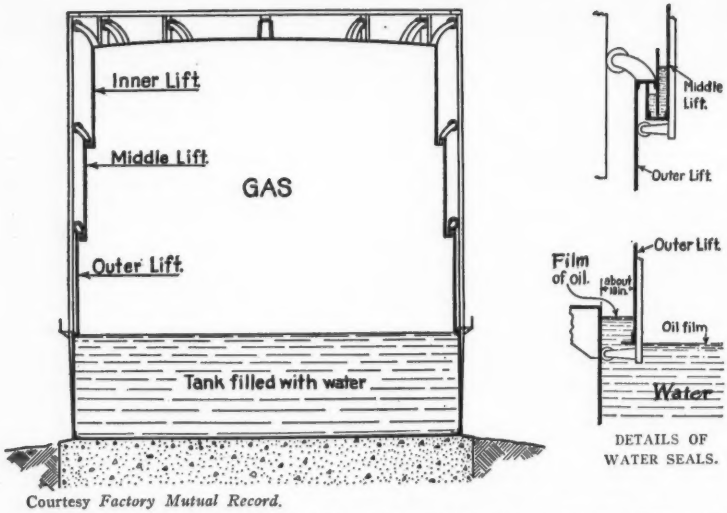
There have been few such fires. In the fire record of Gas Plants published in the QUARTERLY a year ago (Vol. 19, No. 3, page 284) there were nine fires given as in gas holders. During the past year there have been two important gas holder fires, and the unearthing of a clipping describing an earlier fire, provides a total of twelve fires for study.

In the following fires, the age of the holder or gasometer was known to be from 25 to 40 years, so that the possibility of deterioration may be a factor.

H-5948. HOUSTON, TEXAS, DECEMBER 3, 1910. An auxiliary tank 40 years old containing Pintsch Gas is supposed to have sprung a leak, which ignited from an open light in an adjoining building. This caused an explosion, rupturing the tank. The fire was put out by piling sandbags over the break.

H-18866. CHICAGO, ILLINOIS, JULY 31, 1922. This gas holder, which was about 28 years old, contained some 4,000,000 cu. ft. of gas. Its steel plates had become very badly rusted, and very little was left but a heavy coat of paint in some places. Probably a leak in one of the top plates suddenly grew larger by the failure of some of these plates, thus liberating the gas and allowing the tank to fall rapidly. Steel splinters were actually shaved off from many of the parts and heat enough was very likely generated to ignite the escaping cloud of gas above. Eye witnesses report that there was no loud or violent explosion, but rather an immense ball of fire which hung suspended in the air for 10 to 20 seconds, followed by a tremendous heat wave 2000 feet in all directions which started numerous small fires and burned many people.

The American Gas Association reports that this particular holder had been used for the storage of crude natural gas by a company that previously owned it. The excessive corrosion which is supposed to be responsible for the tank's failure was apparently due to the presence of hydrogen sulphide and oxygen.



Courtesy *Factory Mutual Record.*

Section through a typical telescopic gas holder. The one illustrated has three "lifts" or upper sections. Note the details of the water seals on which oils accumulate.

H-23909. EVANSVILLE, INDIANA, JUNE, 1926. A fire practically wrecked a large gas holder, of the ordinary collapsible or telescopic type of half million cubic feet capacity, built in two sections of No. 6 gauge iron, 110 feet in diameter and about 36 years old. As in holders of this type, the lower section was stationary, while the upper section moved vertically, which movement was controlled by the pressure of gas against the roof or crown, which thus supports the entire weight of the top section.

The holder was being filled rapidly when it became lodged in its guide frame. This increased the pressure on the crown sheet and this increased pressure together with the weight of the top section (some 76 tons) was apparently too much for the crown section which gave way, suggesting that it was in a weakened condition. Reports differ as to whether anything that could be called an explosion took place, but certain it is that the liberation of gas through the crown, caused the holder to descend rapidly. This no doubt caused abrasions and heat enough to ignite the oils which are always present floating on the water seal of the holder, and perhaps some of the escaping gas, causing a hot fire. It is estimated that there was about 5,000 gallons of oil to burn and although the fire was put out in about 30 minutes the holder was completely wrecked, and some slight damage was done to a holder 15 feet distant.

Perhaps the too rapid filling of this holder was responsible for its lodgement in the frame. Certainly this put undue stress on certain parts of the tank. In the following fires, the uneven movement of the sections that are designed to rise or fall according to the gas capacity, failed to move freely and ruptured the shells. As neither of these holders was more than ten years old it is assumed that neither was particularly weakened by corrosion.

H-2928. PHILADELPHIA, PA., MAY 23, 1905. During the drawing of gas from one of the large holders, the holder was interrupted suddenly on its lowering, causing a cushioning of the gas against the crown of the holder, rupturing the riveted seams and making a large opening, allowing the escape of all the gas. The ruptured holder was one of three situated close together, each having the capacity of 2,800,000 cu. ft., measuring 134 feet in diameter and 60 feet high.

The gas or vapor was what is termed "Oil Gas" used for enriching. It is a product of petroleum. Being heavier than coal or water gas it descended and was carried by the wind along the ground over an open field. A few seconds after its escape the heavy volume of the gaseous mixture covering a space 800 feet long and about 500 feet wide became ignited by a flash. In the path of the flame were three buildings: one a meter house of the gas company. The vapor entered these buildings and the resulting ignition damaged two of them considerably. The damage of the meter house was mainly due to explosion. Several of the employees of the company were caught in the vapor and before they could escape they were burned to death. The flash lasted only a few seconds, but the gaseous mixture was very hot, even setting fire to the grass on the ground.

The holder was of the telescope pattern, being in three sections, and had been used for six years. The lower section and upper one were in proper position, but the middle one projected about three feet above the level of the pit, showing that it had been obstructed on its way down. It was supposed that the vapor was ignited by either the fire pot of a plumber who was working in the dwelling house, or from a gas flame in use to heat water in one of the other buildings.

H-23910. POSEN, POLAND, FEBRUARY 26, 1926.[1] Severe damage to a large gasometer of the Posen Municipal Gas Works was caused by an explosion which occurred about 1:30 P. M. Having been constructed in 1916 according to the so called "dry system," this gasometer did not, like most holders, consist of a movable bell, closed below by water. It was a stationary, vertical tank of sheet iron, roofed, and of a size which corresponded to the maximum gas contents required. Inside this vertical cylinder was a huge disc-shaped cover arranged to rise or sink as the gas contents of the tank increased or diminished. The disc was gas tight at its edges.

With regard to the cause of the explosion it was reported that the gasometer had become leaky; so, for the purpose of making a thorough inspection and repairs the gas was being drawn off to another holder. The movable disc failed to follow down behind the receding gas in a uniform manner, sinking more on one side than the other. Hence gas was discharged through openings formed when the cover assumed an oblique position. An air and gas mixture probably formed in the space above the cover and below the roof, being ignited supposedly by heat or a friction spark caused by the uneven settling of the disc.

The explosion that ensued was violent, blowing off the roof of the holder completely. According to reports all windows and many doors of most of the buildings in the neighborhood were smashed, and some roofs suffered. The effect of the explosion extended over a distance of almost three-quarters of a mile from the holder; on the Wolnosci (Liberty) Square a whole row of shop window panes was broken, although these were approximately 3300 feet from where the explosion occurred.

After the explosion the remaining contents of the tank burned up, developing much smoke, but doing no further damage. The fire department let it burn as it did not threaten the neighborhood.

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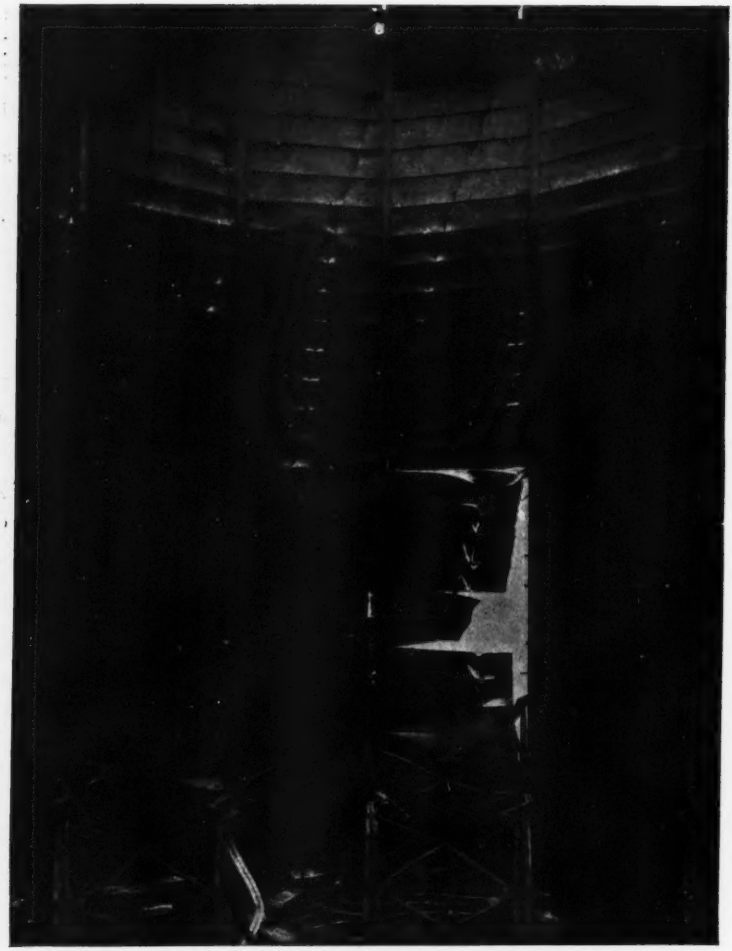
[1]Report on this fire furnished through courtesy of Professor H. Henne (Member N.F.P.A.) Direktor der Deutschen Feuerversicherungs-Vereinigung, Berlin, Germany.



A photograph of the inside of the holder at Posen, Poland. The marks made by the uneven descent of the inside cover are plainly shown together with the rupture they caused.

Two of the fires reported, though widely separated in location, are much alike in details:

H-20893. NORTH MELBOURNE, AUSTRALIA, MARCH 22, 1924. Workmen were patching a gas holder using an electric welding apparatus. A tool apparently struck a weak spot in the plate and caused a rupture allowing gas to rush out. It ignited at once and shot a flame outward 100 yards or more, damaging several houses. The jet was finally extinguished when clay and red lead was plastered over the rupture by men working under the protection of hose streams.

H-22551. CAMBRIDGE, MASS., SEPTEMBER 23, 1925. Workmen were doing riveting on the roof of a gas holder when a leak developed and the escaping gas ignited forming a huge jet of flame. The gas was pumped out of the tank while hose streams kept the tank cool.

The Evansville fire reported above is one instance of a fire in the oils on the water seals of these holders. The Pittsfield fire that follows is another case. It is also likely that the following fire at Hoboken was in the oil seal although definite data seems to be lacking on the exact location of the fire.

H-995. HOBOKEN, N. J., APRIL, 1906. A gasometer took fire from an unknown cause and burned for several days before the gas was entirely consumed. Intense heat was given off doing some damage to exposed structures. Nothing could be done to put out the fire. The gasometer frame and shell were completely demolished. While burning it was felt that it constituted a serious hazard as air must have entered the tank and mixed with the gas. No explosion occurred however.

H-21529. PITTSFIELD, MASS., DECEMBER 16, 1924. Oil floating on the lower water seal above a large gas holder became ignited in some manner. Two men were at work on the frame work of the gas holder at the time the fire started, and it is believed that one of them may have dropped a cigarette into this seal. The burning of this oil generated heat enough to cause the gas in the holder to expand to its limit, after which the gas proceeded to bubble through the water seal and add fuel to the fire. Collapse of the structure was prevented by keeping the steel work cool by means of hose streams.

In the older type of gas holder, where the tank was placed inside a brick structure there seems to be a hazard due to the accumulation of gas and air mixtures between the iron or steel tank and the brick wall of the building, as illustrated by the following fire:

H-2452. HOCHELAGA, QUEBEC, JANUARY 18, 1908. This was a brick building, metal roofed with the gas tank inside. About 5 A. M. it was destroyed by an explosion which wrecked the building. Apparently there was no fire. The gas is assumed to have collected from a leak and become ignited by defective electric wiring.

Lightning seems to be a hazard in holders of construction similar to the one above, where there is a wooden, ungrounded roof:

H-21263. TAUNTON, MASS., JULY 25, 1924. This was a steel holder, bricked in, with a wooden roof. Lightning struck its wooden cupola, burning the same.

In a newspaper report describing the gas holder fire at North Melbourne above, reference to a fire in a holder at Port Melbourne, April 4, 1920 is made. On that occasion the clipping relates that a large gas holder burst without warning, and that flames were seen to rise 400 ft. in the air, visible for miles. Although the immediate plant was severely damaged, scarcely any damage was done outside the works.

Summary.

In the Chicago fire, weakness of the tank shell was evident. The behavior at Evansville, in view of the age of the tank also suggests a deteriorated condition. The fires at Cambridge and at North Melbourne

Courtesy *Factory Mutual Record.*

Fire on a gas holder at Pittsfield, Mass., where oil floating on the lower water seal became ignited. Hose streams kept the holder cool and prevented its collapse.

were due to repairing operations to the shell, which presupposes that corrosion was taking place. The failure at Port Melbourne may have been due to weakened plates, although we have no definite evidence on this point. Too, the leak at Hochelaga *may* be explained by corrosion.

The fires at Philadelphia and Posen were mechanical ruptures simply, due to the rapid drawing off of the gas in the holders, which perhaps made the heavy parts of the holders move more rapidly than they were designed to move.

The corrosion of holders can apparently be guarded against, for the American Gas Association reports that holders over 60 years of age are often found on inspection to be in a remarkable state of preservation. One holder 40 years old was reported to still show on its internal surfaces some of the original marks of the manufacturer or fabricator.

The oil accumulations on the water seals of the holders present an appreciable hazard as shown by the fires at Pittsfield and Evansville and possibly Hoboken. The lightning fire needs no comment.

How the Fires Were Put Out.

Where there was any fire that needed fighting, the procedure appeared to be to play water streams on the holder to keep its contents cool. This being done at Houston and North Melbourne, it enabled the huge jet of flame in each case to be put out by piling sandbags or clay over the rupture;

at Cambridge, it enabled the operators to draw off the gas to another holder. At Posen, Hoboken, and Philadelphia, the fires were allowed to burn themselves out. At Evansville and Pittsfield the fires in the oil on the water seal may have been put out with foam, although the reports do not so state. The cupola ignited by lightning was put out by a fire department hose stream with slight damage.

The Character of the Hazard.

That for the purposes of this record, the reports of only a dozen fires could be assembled shows that fires in gas holders are of comparatively rare occurrence. Even though several of the fires that have occurred have been serious, only one or two did material damage beyond the immediate vicinity. In only one fire was there loss of life, at Philadelphia. This fire sent a wave of flame close to the ground over a wide area, whereas in other fires most of the gas burned high in the air. The gas at Philadelphia was an oil gas used for enriching, and as it is heavier than air, it may be considered a greater hazard than ordinary illuminating gas.

The *Factory Mutual Record,* published by the Inspection Department, Associated Factory Mutual Fire Insurance Companies (Member N.F.P.A.) in describing the hazard of gas holders, concludes that the gas holder constitutes no great exposure hazard to the buildings in its neighborhood, and certainly is a much less severe exposure than a lumber yard or wooden buildings of quick-burning construction.

Gas holder fires may be prevented by careful maintenance which will prevent corrosion or other mechanical failure. The severe corrosive action feared, apparently comes from gases containing hydrogen sulphide. Fires may sometimes occur in the oil on the water seal, but these fires should be readily controlled.

The accident prevention committee of the American Gas Association (Member N.F.P.A.) issued the following bulletin in 1924 regarding the prevention of gas holder fires.

Preventing Holder Accidents.

Several recent accidents have demonstrated the necessity for making complete periodic inspections of gas holders to detect evidences of corrosion, distortion and other detrimental conditions. Insufficient importance is sometimes attached to routine inspection, especially that of smaller holders and those housed within brick structures. This inspection should be made regularly and methodically in order to determine local areas of corrosion and to reveal conditions which, if promptly attended to, will prevent further depreciation.

1. If a holder has been in service for several years, especially if it has been known to have stored gas containing a considerable quantity of hydrogen sulphide, or other deleterious constituents, a thorough examination should be made *at once.*

2. If conditions are such as to warrant it, and it is impossible to make an internal inspection, plugs of metal should be taken from critical points on the crown

of the holder and the corrosion measured from these samples. The edges of the holes should be carefully calipered from time to time to detect evidences of further corrosion. Particular attention should be paid to the interior seam laps in the crown, and to the interior surfaces and plates at places close to the seams. This especially applies to those circles near the crown plate.

3. Holder water should be periodically tested for acidity and for heavy concentrations of harmful salts.

4. Heaping cinders against the outside of the tanks will lead to considerable external corrosion. Nothing should be placed against the metal of the tank above the concrete of the base.

5. The holder crown and frame should be kept free of any cinders which come from nearby smoke stacks, since local corrosion may occur, due to their acid nature in the presence of moisture.

6. The holder cups should be carefully inspected for corrosion, since this action is likely to be more concentrated at any water line which is maintained at a fairly constant level. They should be particularly inspected and regularly cleaned to remove any silt, dust, leaves, ashes, or any other foreign matter that may collect in them.

7. The guide framing should be plumbed regularly so as to determine any deviation from the vertical and its attendant strain on the entire structure. The rollers should be inspected for wear and maintained in proper lubrication and in actual contact with the bearing surfaces. The roller faces and the bearing surfaces should be kept free from binding rust.

The producers and distributors of illuminating gas have every incentive to maintain proper conditions in order that they may give uninterrupted service, so it is likely that the above suggestions will be carefully carried out.

That the likelihood of fire in gas holders is comparatively remote is shown by the fact that there have been so few fires; that in at least one of the fires on record there was loss of life, and in several others serious injuries to persons nearby shows, however, that there is potential hazard to life, even though the hazard to surrounding property is low. In most of the fires recorded where a large quantity of gas was released, it fortunately burned high in the air; had there been atmospheric or wind conditions which would have caused this combustion to take place near the ground, there might well have been serious loss of life. Summed up, it appears that the life hazard, while potentially serious, is at the same time somewhat remote.

A $100,000 Dip Tank Fire.

Report by Western Factory Insurance Association.

(Member N.F.P.A.)

Fire starting apparently in a hot-air heated enamel bake oven spread to two 5,000 gallon dip tanks in an automobile factory in Pontiac, Michigan, September 27, 1926, and damaged the entire dipping machinery installation of the plant, causing a loss estimated at $100,000. This fire and its large loss is interesting because the installation involved, that of enamel dipping and drying, was designed along modern lines and embodied the modern features of protection.

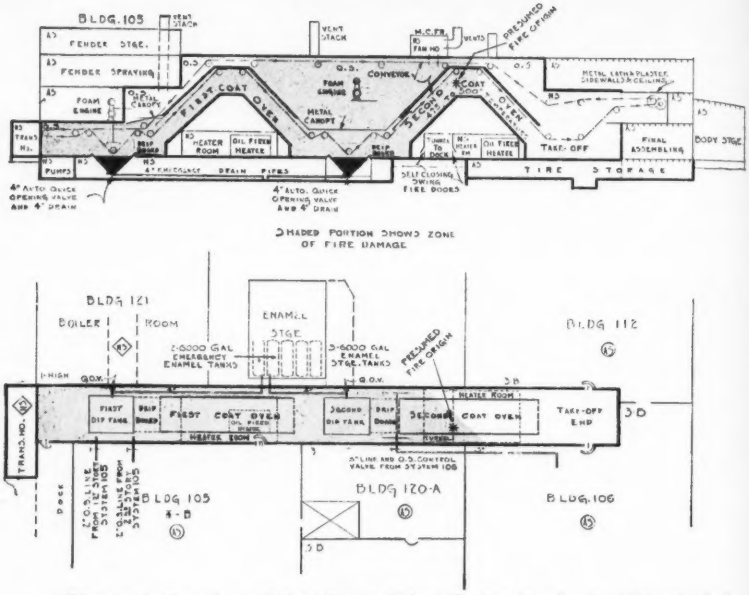
The room in which the enameling equipment was installed was a single story equal to three stories in height, specially constructed, fire resistive with concrete floors and roof on protected steel members. Brick walls with fire doors at openings cut off this section of the plant from the rest. The value of the superior construction was demonstrated, as it was the factor that made it possible to confine the fire to this room.

The Installation.

The accompanying diagram shows the arrangement of the installation. It consisted of two tanks each containing 5,000 gallons of naphtha-thinned enamel, two ovens of heavily insulated steel, and a progressive chain conveyor system extending through the tanks and ovens. The ovens were heated by two oil fired heaters housed under the ovens and cut off from the rest of the installation. Oven temperatures reached 450° F. to 500° F. Each dip tank had 4 in. overflow connections and 4 in. emergency drains equipped with 4 in. quick opening valves controlled by special heat release devices, the overflows and drains discharging to outside emergency receiving tanks.

The only exposed steel was in the enameling machinery itself. There was a small metal lath and plaster extension of the dipping room to house the driving mechanism of the conveyor chain at the eastern end. Ventilation of the dipping room was secured through inside fans which withdrew air at the receiving end of the oven tunnels discharging through roof stacks equipped with ventilator hoods. Hot air from the heaters was injected at the outlet end of the oven tunnels.

The concrete ceiling of the dipping room was equipped with a system of open sprinklers, supplies for these coming from sprinkler systems in the adjacent buildings with manually controlled valves outside the dipping room itself. Metal water sheds or canopies were installed over the dip



Plan and elevation of the dip tank installation involved. The shaded area shows the zone of fire damage.

tanks to prevent the sprinkler water from interfering with the foam protection provided for the enamel dip tanks, drain boards and oven entrances.

There were two foam engines, each with two solution tanks interconnected and controlled by a quick opening valve actuated by heat releases situated over the dip tanks and at the mouths of the ovens. One foam engine was located outside the enamel room, the other inside and directly over the tank which burned. Foam was delivered through single 4 in. pipes from each engine to distributing pipes supplying open sprinkler heads at the oven entrances and over the drain boards, and to open "shovel" type orifices at the edge of the drain board and to combination retarding mixing chambers directly over the dip tanks. Both engines had been recently recharged. Original tests made on one of these engines on October 30, 1923, showed unsatisfactory results in character of foam delivered, indicating the improperly synchronized mixing of the two solutions at different points of discharge. The mixing boxes or retarding chambers which were added to the discharge orifices over the dip tanks, to a great extent overcame this defect. The entire foam installation was made up of approved and unapproved devices which had been assembled as quickly as possible to provide needed protection against enameling

operations which could not be delayed until fully approved equipment could be secured. It was accepted as the best protection available under the circumstances, but was never formally approved by the inspection department.

Story of the Fire.

The enameling department had started operation shortly after midnight as it was working a night shift to keep up with production of other departments. About 5:45 A. M. an employee saw black smoke coming from the take-off end of the second oven. Just before this the foreman had been in this take-off end of the dip room to make sure that parts were progressing through the process in good order but had noted nothing unusual. The interior of the ovens, dip room and heater had been cleaned thoroughly the day before.

Apparently the fire flashed from the second coat oven to the second coat dip tank, thence to the first coat oven and the first dip tank. Both foam engines operated and were drained of solutions. All automatic sprinklers operated and the manually controlled open sprinklers were promptly placed in service.

The conveyor chain carrying stock through the tanks and ovens, traveling 40 in. per minute, was allowed to run in the first stages of the fire, and exhaust fans were operated throughout the entire fire. Fire doors were kept closed and hose streams, although laid by the fire department and ready for use, were not used.

The automatic drains operated, but the emptying of the tanks was materially delayed by the 4 in. openings, and probably further slowed up by sticky deposits and friction in the quarter turn fittings. The fire on the first coat dip tank was extinguished and remained out as a result of the automatic foam application. The foam on this tank was apparently not disturbed by moving stock, the little stock in place at the start of the fire having moved on into the oven or else the conveyor had been stopped, before the fire had flashed to this tank. The fire in the second tank burned fiercely for some thirty minutes apparently until its fuel was exhausted when the enamel was finally emptied through the 4 in. emergency drain. The failure of the foam to hold on this tank may possibly be due to the running of the conveyor chain in the early stages of the fire. Perhaps, too, the quality of foam left something to be desired.

As no fire got outside the enamelling room, no sprinklers outside were opened and no damage was done. The sprinklers in the room itself did much to keep the equipment cool and reduced the loss by heat distortion very materially, likewise preventing spalling of the concrete construction which might have exposed the encased steel structural members. The public fire department showed good judgment in not using hose streams

which might have flooded the burning enamel into the basement or adjacent rooms.

The damage is principally confined to the loss of the burned enamel, to the ovens and the accessory apparatus in the dipping room. While the intensity of the fire was doubtlessly increased by operating the fans continuously throughout the fire, there was felt to be danger from explosion during the fire if the fans were shut off, and so this procedure was probably justified. It is estimated that this department will be out of commission for at least a month before the damage can be repaired.

Cause of the Fire.

While the exact cause of the fire is not definitely established, it evidently started in the hot zone of the second coat oven, where temperatures range from 475° F. to 500° F. At the start of the fire, recording instruments indicated a sudden rise in temperature to 700° F. As the oven had been cleaned the day before the theory that the fire was caused by carbon deposits, enamel residue, rags or other foreign material is eliminated.

The more probable cause lies in the fact that the conveyor system had been speeded up from a normal progress of 30 in. per minute to 40 in. per minute. Under this increased speed, the pieces dipped were probably still dripping fresh enamel when they reached the hot zone of the oven so that these drippings flashed as they came in contact with the hot floor of the oven. This actually occurred two or three months previously, when workmen found dipped pieces coming through on fire.

Possible origin of the fire in the heating units was considered and investigated. It was found that the oven heating units were in perfect condition and performing their normal functions at the time of the fire.

Conclusions.

Although this large loss occurred in an installation that was substantially in accordance with modern practice, it is not fair to assume that the existing practice on installations of this kind is faulty. Following are some reasons why this fire was not more promptly controlled and extinguished at reasonable cost.

The 4 in. emergency drain outlets were undoubtedly inadequate to draw the enamel off the tanks fast enough to prevent the fire wrecking the equipment. The drains were put in place without sanction when the installation was made, and the pressing need for the use of the apparatus allowed this deficiency to be left uncorrected. The present 4 in. emergency drains, including the automatic valves and entire drain piping, should be made 8 in.

The failure of the foam on the second tank has already been discussed. To insure the production of good quality of foam, a rearrange-

ment of the present foam equipment has been recommended which calls for the replacement of the present two-tank generating units with approved 40 gallon engines. The piping for the delivery of the foam should also be modified and the orifices changed to improve the distribution, making the mixing boxes or chambers unnecessary.

Provision for connecting the conveyor controls to the heat release devices so that the conveyor will be automatically stopped in case of fire would enable the foam to operate more effectively.

The fire could undoubtedly have been held or extinguished even after the failure or exhaustion of the foam provided, had there been an emergency arrangement to permit the mixing of foam ingredients and the injection of foam from the outside of the room to supplement the stationary system there. This could be obtained either by a reserve of several approved 40 gallon engines or by a continuous foam generator producing foam from dry ingredients and water. A hose connection could be provided outside of the enamel department where these supplementary devices could be connected up, said connection to deliver foam to a permanent system of piping and orifices inside. This would permit of a continued supply of foam in case of an unusually severe fire.

The intensity of this fire indicates that the expense of segregating the entire dipping operation in a room of rugged fire resistive construction is fully justified. The handling of this fire reflects credit on the plant management and the public fire department, who allowed it to burn out rather than risk spreading it by the use of hose streams.

A Sprinkler Failure in a Rubber Plant.

Report by Underwriters' Bureau of New England.

(Member N.F.P.A.)

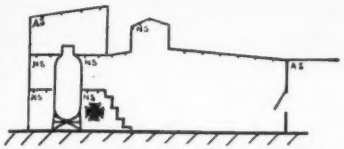
Failure of automatic sprinklers due to serious obstructions to proper distribution of water, combined with poor protection, indifferent fire fighting and weak water supplies, caused the destruction of a rubber reclaiming mill at Franklin, Mass., in the early morning of December 3, 1926. Damage totalled at least $250,000.

The plant was of mixed brick and frame timber and joist construction. Processes involved were principally cutting and grinding of old automobile tires, devulcanizing, milling and churning in connection with the manufacture of "electric" tape and insole cloth. The special hazards, while considerable, were not unusual to this class of occupancy.

A nearly complete modern sprinkler system protected the plant of the "wet" type in the manufacturing areas, supplied from an indifferent water works system and a 10,000 gallon gravity tank. The water works supply was from a dead end 6 in. street main fed one way from a 12 in. main 1700 feet distant. Static pressure at the plant varied from 75 to 100 lbs. depending on whether or not the pumps to the 440,000 gallon water works standpipe were in operation. Tests at various inspections had shown drops of pressure under flow varying from 25 to 45 lbs.

Although standard watchman's service was provided, the plant was without water flow alarms in the manufacturing buildings. Outside protection was considered poor. There were only two hydrants within 500 ft. of the plant, both fed from the 6 in. main mentioned above. The owners of the plant had some hose and the public call fire department had a pumper one mile distant.

The fire originated in the frame, part timber, part joist washer room shown as No. 8 on the accompanying plans. This building was one story in height except for an area 89 x 15 ft. at the east side where the roof was raised to form a second story, which roof house was to provide for four tall digesters which rested on the ground level and projected up through a charging platform under which there were no sprinklers. Sprinklers in this area had been suggested to the owners, who were planning to install them. These digesters occupied the northeast corner of the building. In the main one story section of this building were washing machines, a wringer and a dryer. This building was not considered to have been cut off from the rest of the manufacturing areas. The westerly wall between the buildings marked No. 8 and No. 7 on the plans might

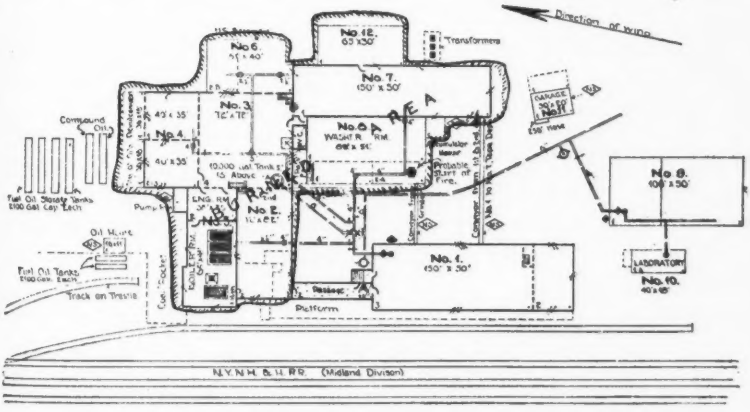


Section of building No. 8. The fire apparently started under the unsprinklered decks as marked by the cross.

have provided a barrier to the spread of fire if it had been aided by hose streams, but at the south the wall of the four story building (No. 3) which was 10 ft. distant had unprotected windows on all floors and was connected to No. 8 by an open passageway and conveyor chute on the second floor.

As far as can be learned the following was the sequence of events. The watchman states that he made his 3 A. M. round and found nothing unusual. He states that he stopped in building No. 8 for a few minutes, watching a train that was passing. About 4 A. M. he made his next round and discovered No. 8 building all ablaze. As the nearest fire alarm box is some 2500 feet distant, the watchman used the telephone, but the line to the fire department was busy. Returning to the boiler room he blew the factory whistle, and as he returned to the telephone he heard the town fire whistle blow. It appears that meanwhile employees on the night shift at a plant about a quarter of a mile distant had noticed fire at this plant and apparently watched the flames for ten or fifteen minutes before it occurred to them that the fire department should be notified. This was done by telephone at about the time the watchman discovered the fire.

The chief of the fire department and another man sleep at fire headquarters, but it was about ten minutes before the apparatus reached the



A plan of the entire property. Fire starting where indicated in building No. 8, spread readily to the adjacent manufacturing areas due to lack of cutoffs, shortage of water and unintelligent fire fighting.

fire. Two hose streams were laid from the hydrant between buildings No. 9 and No. 11, the hydrant near building No. 1 being considered too near to the buildings. Apparently the judgment used in directing the hose streams was not good. The wind was blowing from the north but it appears that the fire had not penetrated into building No. 3 to any extent before the fire department arrived and that if hose streams had been taken into No. 3, it might have been possible to have checked the fire at this point. The possibility of this was in the minds of the mill superintendent and a mechanic when they arrived at the plant. They went through building No. 3 to a small service pump in building No. 4. Connecting a hose line to this pump they started it, but before the stream could be put into action a high pressure stream line in building No. 8 burst and took all the steam away from the pump.

Sprinklers were at this time operating in buildings No. 2 and No. 3 because the superintendent and mechanic were soaked in passing through. About this time the roof and second floor of building No. 8 fell in and broke off the 4 in. sprinkler riser, so much water being lost from this break that the fire department tried to shut it off. There was apparently some confusion as to which valve should be shut and it appears that several valves were shut before the correct one was learned. The fire was by this time beyond the control of sprinklers, and the gravity tank was probably dry and the hose streams were taking most of the town water so the shutting of these valves was probably not a factor in the final result. At no time were more than three hose streams in operation, two coming from the Franklin pumper at the hydrant near building No. 9 and one stream from a Wrentham pumper over 500 ft. distant on the 6 in. main.

The fire burned itself out in the manufacturing areas, most of the walls falling in. Building No. 1, a modern well constructed building used for storage and detached by from 45 to 60 ft. from the other buildings, was not damaged, fire doors keeping the fire from entering through the passageway to building No. 2, and hose streams putting out fires that spread along the unsprinklered conveyors between this building and Nos. 7 and 8. Other detached buildings, Nos. 9 and 11, were not damaged.

Cause of the Fire.

What caused the fire cannot be definitely stated. The probable cause was spontaneous ignition in chopped rubber tires, containing cotton fabric, mixed with a caustic. This material was loaded into digesters from the charging platform and was more or less soaked with pine oil. Some of this material had fallen between the digesters and the platform. Although frequently cleaned out, at times enough accumulated here to support combustion and was doubtless subject to spontaneous ignition. While there were sprinklers over the digesters there were none under the charging

platform, which seriously obstructed distribution of water on the fire. The accompanying sketch shows the approximate condition.

The effect of this construction was sufficient to permit the fire to assume large proportions before it reached the areas where sprinklers would normally be effective. At this point in the progress of the fire, the late arrival of the fire department due to delayed discovery and alarm, the broken sprinkler riser, hose streams taking water from the sprinklers, the shutting off of sprinkler valves and poor fire fighting are so interrelated that the blame cannot be definitely placed for the fire assuming the proportions it did.

Reason for Sprinkler Failure.

There is no reason to believe that the sprinklers were shut off and that the watchman opened the valve when he discovered the fire. An insurance company inspector who had visited the plant within a week had found the sprinklers in service.

The obstruction to sprinkler distribution was apparently sufficient to allow the fire to gain great headway in No. 8. The lack of cutoffs permitted the fire to spread into the other areas, although it seems that the sprinklers did hold the fire out of these areas for some time as the plant superintendent and a mechanic were able to pass through these areas as late as an hour after the fire is believed to have started. However, the opening of an increasing number of sprinklers and the taking of more water by hose streams depleted the water supply and the fire passed beyond sprinkler control. The emptying of the gravity tank and the breaking of the sprinkler riser and possibly the shutting of a wrong sprinkler valve were contributing factors.

Earlier discovery and more efficient fire fighting would probably have confined the fire to the building of origin.

The fire demonstrates the necessity of providing sprinklers under all platforms, the value of locating a fire alarm box at a plant such as this, the value of water flow alarms, physical barriers such as fire walls and doors, the distinct marking of sprinkler valves and the necessity for adequate water supplies.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred that they may be known and guarded against.

Kerosene in Kitchen Stoves.

L-66. PITTSFIELD, MASS., NOVEMBER 2, 1926. A mother was fatally burned and her four-year-old son was taken to the hospital for treatment, as the result of an explosion when she started a fire in the kitchen stove with kerosene.

L-69. NASHVILLE, TENN., NOVEMBER 6, 1926. A mother and her two small children were burned to death and a nine-year-old daughter died a few hours later from burns she received when fire destroyed their home. The father had poured kerosene into a stove and an explosion followed. He and his mother were seriously burned in making their escape.

L-70. FORT DODGE, IOWA, OCTOBER 16, 1926. A man, 85 years old, attempted to start a fire in the kitchen range with kerosene. The oil exploded and enveloped his body in flames. He ran from the house and his cries for help were heard by his son, who lived a short distance away. By the time he reached his father the old man was so badly burned that he died the next day in the hospital.

Bonfire.

L-68. PHILADELPHIA, PA., NOVEMBER 5, 1926. Five children had finished helping their mother rake the leaves in their yard and were standing by watching her as she set them on fire. She had set a match to the pile when a gust of wind blew the burning leaves in her direction. In a flash her clothing was in flames and she died five hours later from her burns.

Plastic Flooring.

H-23797. UNIVERSITY CITY, MO., SEPTEMBER 21, 1926. HIGH SCHOOL. An explosion, caused by the ignition of flammable vapors from the solvent of a plastic floor covering which was being laid over the floor of a newly erected auditorium, occurred in a pipe tunnel beneath the floor. One workman was killed and ten persons, including three students attending classes, were injured. What caused the ignition of the flammable vapor is not known. The man killed was one of three at work removing wood forms from the inside of the tunnel; his body was found in the pit at the end of the tunnel in the boiler room. A fire drill well organized and practiced saved the 990 students from a possible panic; the children left the building without disorder.

Disinfectant.

S-43193. NEWBURYPORT, MASS., SEPT. 17, 1926. SHOE FACTORY. An explosion of a partially filled drum of disinfectant resulted in fatal burns to an employee and a flash fire which was controlled by sprinklers. While the cause of the explosion may never be definitely determined, it may be assumed that the employee burned went to the basement in order to get some of the disinfectant for home use and struck a match in order to examine the amount in the nearly empty drum, the resulting flash of the vapors inside the drum causing the explosion.

Children and Matches.

L-62. LYNN, MASS., SEPTEMBER 23, 1926. A three-year-old child was fatally burned while playing with matches in the bedroom of her home. Her father heard her screams and rushing in to the room saw the bed on fire. It was only after he had thrown the blazing mattress out of the window that he saw the child under the bed. She was rushed to the hospital where she died shortly after being admitted.

L-67. EVERETT, MASS., NOVEMBER 2, 1926. A five-year-old child, playing with matches in the yard of her home, ignited her clothing. She was taken to the hospital where she died the next day.

Gasoline.

H-23829. CHELSEA, MASS., OCTOBER 14, 1926. A twelve-year-old boy lowered a small bottle into the tank of an automobile and then lighted a match to see if the bottle was full. The exploding gasoline set fire to his clothes. Two men who were passing wrapped the youngster in burlap bags to extinguish the flames. He died a few hours later in the hospital.

H-23721. MORRIS, ILL., AUGUST 7, 1926. A tank wagon was being loaded with gasoline when it suddenly burst into flames. The motor was not running and the truck was grounded. The only possible cause seems to be static electricity. The driver died as a result of burns before he could give a coherent account of the accident.

Dust Explosion (Fertilizer).

S-43589. KANSAS CITY, KANSAS, NOVEMBER 6, 1926. MEAT PACKING PLANT. Hoof meal was being ground in the fertilizer section of this plant. It is probable that the atmosphere was rather badly clouded with the fine dust. There were two vent fans in the room used to draw off the dust laden air. It is not known definitely that these fans were in operation as the man that had charge of them was fatally injured. About an hour after the plant had started operation the workmen noticed fire coming from spouts connected with the grinder and almost instantly the explosion occurred. Nine men were injured by the explosion, mostly from burns. Two men died from injuries received.

Black Powder.

S-43279. LOWELL, MASS., SEPT. 15, 1926. CARTRIDGE FACTORY. A fire occurred when a tunnel loading machine containing about two pounds of black powder exploded from an unknown cause. The clothes of the woman operator of the machine caught fire and she was fatally burned.

Automobile Truck.

H-23845. DAYTON, OHIO, NOVEMBER 1, 1926. A mother and six children died from burns suffered in the wreck of the truck in which they were riding when it collided with a street car and another truck. Six other people were injured, three possibly fatally. The accident happened as the two trucks crossed a bridge. One driver attempted to pass the other and drove his machine head-on into the street car. Almost immediately that truck burst into flames which shortly involved the other one also.

Apartment House.

H-23798. ST. PAUL, MINN., SEPT. 23, 1926. APARTMENT HOUSE. Fire, which started in the basement of an apartment house caused the death of one man, and another man was overcome by smoke. Both of the men were in the basement where the fire started, and had they not been under the influence of liquor they could have easily made their escape. The drafts of the heating boiler had been entirely closed and there was an internal explosion of coal gas which ruptured the breaching and allowed the burning coal gas to ignite the woodwork near the boiler. This in turn melted off a row of eight gas meters. The ignited gas caused most of the damage.

Gas Stove.

L-75. PHILADELPHIA, PA., NOVEMBER 16, 1926. A woman was so severely burned in a gas explosion that she died two days later from her injuries. She struck a match to light the oven burners in a gas stove. The oven in some way had become full of gas, which exploded.

Burning Dwelling.

L-78. NORWAY, ME., DECEMBER 11, 1926. A mother and her three-year-old son lost their lives when a fire destroyed their little farm home. The fire started after the family had retired when some mittens hung over the kitchen stove to dry, took fire. Five children were roused and taken out of the house by which time it was nearly all in flames. The three-year-old boy in the excitement went back into the house. In attempting to rescue him his mother was fatally burned.